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View of Socioscientific Issues Among Educators: The Willingness of Teachers to Accept SSI Into the Classroom and the Reason Underlying Those Beliefs

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by

John Carlos Parr

Abstract of a Dissertation
Submitted to the Graduate School
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
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ABSTRACT

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Socioscientific issues (SSI) are potentially controversial topics, which can be examined using a social and a scientific perspective. The inclusion of these topics in elementary and secondary classrooms has caused a number of conflicts over the past century. In the present study, I explore the willingness of teachers to include three SSI: evolution, stem cell research, and global climate change in the science curricula. Participants included 221 educators currently employed in K-12 schools. Teachers have the greatest impact on classroom instruction, regardless of state curricula. I found most educators willing to include the three previously named SSI in the curricula, but support was not an indication of a pro-science perspective. Teachers modestly preferred the inclusion of scientific perspectives over alternative ideas, but this support was not universal. Potentially important demographic factors were collected; participants from rural populations, Evangelicals, frequent church attendees, Republicans, and conservatives were found to be less receptive to science-supported ideas. A similarly lower level of support was found among those teachers who did not teach secondary science and those who had taken fewer science courses while in college. Interestingly, a possible correlation between the aforementioned demographic factors and chosen teaching position was identified. I identified a perceived low level of support for the

science underlying the selected SSI as one possible explanation for the lack of emphasis on empirically supported concepts. Similarly, the majority of educators were willing to support legislation which formally encouraged the idea of “balanced” coverage. I found the lack of support for scientific ideas and the reasoning quality supporting these views surprisingly low. Educators consider SSI using very different lenses. It was these lenses, and not empirical evidence, which had the greatest impact on decision making. For some participants these frames of reasoning seemed so engrained that they were unwilling to even contemplate the validity of opposing viewpoints.

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SSI	socioscientific issues
SCR	stem cell research
ESCR	embryonic stem cell research
NOS	nature of science

CHAPTER I

INTRODUCTION

The beliefs held by teachers do matter. It is these beliefs which impact classroom instruction and the material presented to students on a daily basis. The personal views of educators are especially important in the examination of socioscientific issues (SSI). SSI have been described as “social dilemmas with conceptual or technical associations with science” (Wu & Tsai, 2007, p. 1166). Such issues of social and scientific relevance have been debated in classrooms across the United States for a number of decades. Debates surrounding these topics are often so emotionally charged that some have described them as wars between two religions (Ruse, 2005), with one side of the debate focused on the advancement of man through science and the opposing side focused on a belief in the divine. The most public of these battles has involved the evolution of human beings. Those opposing the teaching of evolution have found little support within the modern legal system of the United States, but public opinion remains undecided (Berkman, Pacheco, & Plutzer, 2008).

Battles pitting empirical science against personal belief continue to be waged in schools, school boards, town halls, and living rooms throughout the US. These personal debates may have the largest impact on teacher views and subsequent classroom practices. Other authors have summarized the situation by writing, "there are many reasons to believe that scientists are winning in the courts, but losing in the classroom” (Berkman et al., 2008). Differences in science curricula between states can only explain a small percentage of the variation regarding the coverage of socially relevant and potentially controversial subject matter (Rutledge & Mitchell, 2002). Variations within states and among educators remain as the most likely predictors of student experiences within the science classroom.

The possible benefits of SSI extend beyond the formation of well-developed opinions concerning specific scientific topics. The unsettled nature of SSI coupled with the widespread interest has made these subjects a primary concern of those seeking to improve science literacy among the wider community (Kolsto, 2001). Controversial and socially relevant topics may reflect a student's attitude toward his or her duty as a citizen, a participant in the political process, and a member of a larger society (Ehman, 1977). Proper coverage of SSI in the classroom may improve conceptual understanding of broader science concepts (Linn, Shear, Bell, & Slotta, 1999), overall scientific reasoning skills (Zeidler, Walker, Ackett, & Simmons, 2002), and result in a better understanding of the nature of science as demonstrated by students (Bell & Linn, 2002). SSI have been used to improve critical thinking skills (Quitadamo & Kurtz, 2007) and students' ability to form conceptual ties between diverging ideas (Bell & Linn, 2002). Proponents of SSI in the classroom have expressed a belief that such subject matter can enhance the students' overall ability to reason and "think for themselves" (Walker & Zeidler, 2007, p. 1388).

The prominent biologist Theodosius Dobzhansky (1973) famously wrote, "nothing in biology makes sense except in the light of evolution" (p. 125). Despite its importance, evolution continues to hold an unsettled position within many classrooms. This is not a trivial or inconsequential problem; topics covered in the classroom do matter. A proper understanding of certain concepts is likely necessary for the production of a scientifically literate society (Bell, 2003). It is the effort to improve overall scientific literacy that remains a key focus of those promoting the benefits of SSI (e.g., Bell, 2003; Bell & Linn, 2002; Gray & Bryce, 2006; Lewis & Leach, 2006; Linn et al., 1999; Zeidler & Keefer, 2003). Due to demonstrated and potential benefits, some science educators continue to call for an increased focus on SSI in the classroom (e.g. Gray & Bryce, 2006). This increased focus is not limited to practices within the United States; calls to increase the use of controversial subject matter can be heard within the global science education community (Gray & Bryce, 2006; Levinson, 2006a).

The ability of individuals outside of the scientific community to develop well-reasoned opinions is astoundingly important when the topic is socially relevant. The impact of public opinion can be seen in historical and current changes to the education system (Gibson, 2004), but the implications of public opinion are not limited to the halls of school buildings. One need only look to the outcomes of political elections and subsequent political decisions to witness the impact of science literacy. The views of the public can have a direct impact on the work of scientists. Political decisions regarding global climate change and stem cell research are certainly influenced by public opinion, and these decisions can have a direct impact on science research. Public opinion is not necessarily a barrier to scientific research, and opinions are not universal or unchanging.

SSI challenge individuals to reconcile personal views and scientific research. It is likely that this ability to decipher empirical evidence from opinion could result in a society that is able to produce overall better decisions concerning science practices. A proper understanding of scientific practice allows individuals to recognize "pseudoscientific claims, distinguish good science from bad science, and apply scientific knowledge to their everyday lives" (Bell, 2003, p. 64).

Classroom instructors, not an outside group, are frequently the ones who make the decision to avoid addressing social aspects of the scientific issues they are charged with confronting (Hodson, 1998). The avoidance of these topics is likely the result of the conflicts from multiple sources that may ensue when SSI are included in the classroom. Numerous science educators espouse the need to include SSI in the science curriculum, yet few high school courses have been found to adequately address these issues (Lee & Witz, 2009). SSI often receives such limited attention that many students conclude science is uncontroversial and/or unchanging (Driver, Newton, & Osbourne, 2000; Ryder, Leach, & Driver, 1999).

There is no single set of reasons which can be used to explain the decision to include or exclude certain SSI within a classroom, although it does seem that personal beliefs not related to science are impacting these choices. It can be argued from historical evidence that state legislatures create public policies including educational curricula that are driven by the moral or religious values held by a plurality of citizens within a given community or state (Gibson, 2004). The relationship of numerous socioscientific issues to morality, ethics, and/or religion may be an important factor in explaining the dearth of SSI coverage in numerous science classes (Gibson, 2004). The relevant nature of certain topics makes them more susceptible to cultural and historical impacts as compared with their less universally interesting counterparts. It is thought that the beliefs of the public are more likely to impact the behaviors of teachers in the classroom, and less likely to impact the development of statewide curricula. Furthermore, the willingness of teachers to address particular subject matter seems to have a greater impact on the classroom than what is included in the curriculum.

SSI are controversial for a variety of reasons. The dilemmas involved may range from inconclusive scientific evidence to variations in personal belief systems (Levinson, 2006a). Similarly, these topics may be eliminated from the individual classroom for a number of diverging reasons. Some educators have cited a lack of time to fully cover the material as the primary explanation for the avoidance of socially relevant discussions (Lewis & Leach, 2006). Limited understanding of the topic among teachers is another reason cited for the selective avoidance of SSI in secondary education (Davis, Petish, & Smithey, 2006). The views of teachers concerning proper classroom practices impose a significant barrier when attempting to implement any innovative topics into school curricula (Huberman & Middlebrooks, 2000). SSI may arouse strong and differing opinions (Bauer, 1997); thus, fears over student behavior and the possible arguments that may ensue is another common concern. Other apprehensions include who is best suited to decide the topics that should be included and when adjustments to the curriculum should be implemented (Lewis & Leach, 2006). In short, attempts to implement curriculum reforms which focus on SSI must overcome a number of logistical and ideological barriers imposed by educators within each school and classroom.

Simply deciding to address SSI in the curriculum is not sufficient to realize the possible benefits; proper instructional practices must be followed. Such methods have been proposed and rather convincingly supported (Sadler & Donnelly, 2006). These typically involve some explicit form of instruction relating scientific knowledge directly to a controversy that interests the general public. Sparking the interest of the learner can be used as a conduit for discussion and argumentation, which researchers have described as the single most beneficial method for implementing SSI into the school environment (e.g., Aikenhead, 2000; Driver et al., 2000; Lee, 2007; Sadler & Donnelly, 2006; Walker & Zeidler, 2007). Lending credulity to these claims, the greatest benefits from SSI have been seen in reforms which implement instruction in a manner focused on discussion and argumentation (Lee, 2007). While established as best practices for addressing controversial topics, argumentation and classroom discussion are uncommon or avoided in many schools (Newton, Driver, & Osborne, 1999). Furthermore, improper instructional practices may have a negative impact on learning outcomes (Zeidler, 2003). To fully realize the benefits of SSI, educators must be willing to fully engage the process and embrace disagreement.

Three SSI stood out for me as being of particular relevance for different reasons: 1) evolution, 2) stem cell research, and 3) global climate change. These three topics are socially and scientifically relevant and they are each controversial in their own manner. Each of the topics I selected is significant enough to have been included in the National Science Education Standards (National Research Council [NRC], 1996). Efforts at the national level have had a direct impact on subsequent state science standards (Mississippi Department of Education [MDE], 2008). Despite this inclusion in state and national curricula, if teachers are unwilling to fully address certain difficult subject matter, little benefit will be demonstrated.

In the following pages, I evaluate the willingness of educators to accept evolution, stem cell research, and global climate change as aspects of science curricula. These topics were selected based on the criteria developed by Levinson (2006a) and sources which indicate that the topics remain controversial (e.g., Latham, 2009; Pew Research Center, 2009). Different individuals approach socioscientific topics in diverse ways;

respondents have been described in previous research as those with a preference for scientific sources of information versus those with an inclination towards socially oriented information sources (Yang & Anderson, 2003). Reaching conclusions regarding SSI is a process of informal reasoning for both socially and scientifically oriented individuals (Wu & Tsai, 2007). One's ability to reach thoughtful conclusions concerning controversial subject matter is seen as an important aspect of overall science literacy (Sadler, 2004) and should be seen as important among all science educators. This study examines three of the most critical aspects impacting the beliefs teachers hold regarding the coverage of SSI: 1) the willingness of teachers to accept SSI into the science curricula, 2) the factors impacting the aforementioned conclusions, and 3) variations in reasoning among and between SSI supporters and those who oppose the inclusion of the selected topics.

For this study, I developed an instrument to quantitatively and qualitatively assess the views educators hold regarding the inclusion of SSI. The survey and questionnaire were specifically designed to evaluate the beliefs of educators ranging from kindergarten through senior high school. Multiple choice queries were used to evaluate the general willingness of educators to embrace the inclusion of the potentially controversial topics. I developed this assessment using a Likert-style measure designed to gauge levels of support. The development of this tool required an examination of those aspects of the selected SSI which are areas of legitimate disagreement. Levinson (2006a) has produced a framework important in guiding my initial examination of evolution, climate change, and stem cell research. This framework allowed me to limit the scope of the questions used and to focus on the most important aspects of the controversial subject matter. For example, the teaching of evolution is not a matter that will be solved when additional evidence becomes available; the evidence is largely irrelevant (Levinson, 2006a). Instead, the whole framework for understanding and explaining the subject is a matter of disagreement (Levinson, 2006a). In this regard, asking questions related to specific pieces of evidence is unlikely to be a productive task. Instead, efforts can be focused on illustrating different beliefs based on differing frameworks.

Quantitative aspects of this work focused primarily on describing the views of educators and comparing these understandings to various factors which could be possible predictors of opinions. Areas such as religious belief, political ideology, and educational experiences were all included as possible factors underlying the willingness of educators to accept the selected topics into the curricula. On multiple occasions argumentation has been used as a method for evaluating the views held by individuals regarding SSI (Sadler, 2004). These efforts include examinations of the ability or willingness of individuals to formulate arguments and the perspective used by individuals in the development of these arguments.

During the development of this study, Tennessee state representative Bill Dunn and state senator Bo Watson introduced legislation directly related to SSI in the classroom. In Tennessee House Bill 368/Senate Bill 893 teachers are “permitted to help students understand, analyze, critique, and review in an objective manner the scientific strengths and scientific weaknesses of existing scientific theories” (Dunn, 2011, p. 2). Supporters of the bill claim it merely prevents what they believe to be a one-sided debate on topics such as climate change and evolution, while opponents believe the legislation is a veiled attempt to interject non-scientific ideas into science classes (Johnson, 2012). Due to the currently relevant and potentially interesting nature of this legislation, I elected to use this proposed statute as a method for evaluating the views of teachers. I incorporated the law as a platform for assessing reasoning quality and various aspects of informal reasoning. Participants were specifically asked to give their opinions on this or similar legislation which emphasize a balanced coverage of SSI in the classroom.

Views of evolution, stem cell research, and climate change in the classroom were taken from the quantitative portion of this instrument. These results, coupled with those personal views which are possible predictors of opinion, were used to frame and understand responses to multiple-choice and open-ended questions. The quantitative and qualitative aspects of this study were coupled in the development of a comprehensive view of the opinions teachers hold concerning SSI in the classroom.

I began this work in a prior study, which explored the views of non-science majors (Parr, Syed, & Halverson, 2011). This background material revealed a widely held idea that all topics should be covered in a manner that gave equal standing to opposing views. Many respondents were quick to mention religious ideas or other personal beliefs as guides in their decision-making process. Prior research focusing on specific aspects of SSI is abundant; this is especially true for the topic of evolution. It is not particularly surprising that religious aspects are often mentioned in the context of evolutionary discussions. I was unable, however, to locate a study that comprehensively assessed the views of teachers regarding evolution, stem cell research, and global climate change as instructional topics. The significance of the work presented here lies in testing the hypothesis that the views of individual teachers will directly impact classroom practices in a predictable manner, a hypothesis which is supported by prior research.

The mixed-method assessment that emerged was guided by prior work but is distinct from any of these previous instruments. I chose to take a holistic view of the factors that may or may not be impacting the views of teachers. I expected to find a correlation between teaching assignment and certain background factors. For example, secondary science teachers have likely taken a larger number of college science courses when compared with their elementary counterparts. The educators who participated in this study were not, however, treated as uniform groups based on subjects or grade levels taught. Instead, the participating teachers were asked to provide information such as religious and political views. These individual perspectives have been used in previous research as possible predictors of views of SSI. This relationship would be true regardless of profession, but the personal beliefs of educators are more important in the development of scientifically literate society. It is my hope that the insights produced in the following work will be of use to others in the field of science education. I am especially hopeful that this work could have a positive impact on practices within the classroom.

Statement of the Problem

Education policy, including curriculum development, is likely influenced by the beliefs and opinions of those who are not scientists (Gibson, 2004). This is especially true given the controversial nature of certain science topics. Historical and current battles over what ideas should or should not be included in the science curriculum illustrate the unsettled nature of SSI in the classroom (e.g., Armenta & Lane, 2010; Latham, 2009). Defining the process used to reach conclusions regarding these topics remains an area of concern due to the informal nature of the process used to reach conclusions (Braund, Lubben, Scholtz, Sadeck, & Hodges, 2007). Personal beliefs have been shown to be an important factor in decision making among individuals at all levels (Lederman, Abd-El-Khalick, Bell, & Schwartz, 2002). A relationship between content knowledge and the ability to engage fully in reasoned discussion of socially relevant science topics has been demonstrated, but the prerequisite knowledge needed may be relatively simple (Lewis & Leach, 2006). In this work I focus on those classroom teachers who are directly responsible for delivering the material presented in the curricula. It is the personal views of these educators, and not the science curricula, which primarily dictate the coverage of SSI in the classroom (Berkman et al., 2008).

Research Questions

1) Do K-12 educators believe evolution, anthropogenic global climate change, and embryonic stem cell research should be included in science curricula?

2) Do K-12 educators prefer the inclusion of scientifically supported ideas over alternative views supported by other groups?

3) Do K-12 educators personally understand the evidence underlying the topics of evolution, anthropogenic global climate change, and embryonic stem cell research?

4) Whom do K-12 educators believe should be responsible for making decisions regarding the inclusion of evolution, anthropogenic global climate change, and embryonic stem cell research in the science curricula?

5) Do selected background variables (religious beliefs, political beliefs, and number of science courses) relate to beliefs regarding evolution, anthropogenic global climate change, and embryonic stem cell research?

6) Do K-12 educators support legislation which emphasizes the inclusion of ideas which are not scientifically supported?

7) Does reasoning quality concerning SSI vary among K-12 educators?

8) What lenses for decision making are used by K-12 educators when reaching conclusions concerning SSI legislation?

Pilot Study

The work for this study began as part of a required component for a research practicum course. Permission to conduct the study was obtained from the Institutional Review Board at The University of Southern Mississippi, and a paper was produced for the 2011 NARST Annual International Conference (Parr et al., 2011). I conducted the background study in collaboration with Nasser Syed and Kristy Halverson.

Introduction to Pilot Study

The pilot study began as an examination of the perceptions of pre-service teachers regarding potentially controversial aspects of the science curriculum they would be charged with implementing. We later altered the study to explore the beliefs of non-science majors. Topcu (2010) showed that non-science majors have a more negative attitude toward SSI. The preliminary study did not directly measure the attitude of non-science majors; instead the research and questionnaire were designed to explore the beliefs of non-science majors regarding the appropriateness of evolution, stem cell research, and climate change in the high school classroom. This included an assessment of the experiences participants recalled from their own high schools and the sources of information that were seen as the most useful in reaching conclusions regarding SSI. In the following sections I have included the most relevant information from this preliminary study.

Methods for Pilot Study

Participants included undergraduates enrolled in an introductory biology course for non-science majors. Respondents were taken from different sessions of the same undergraduate course. Participation was limited to those students who had graduated from high school in the same southern state within the previous five years. Data were collected using two questionnaires given to the same group of students. The initial questionnaire consisted of 15 open-ended questions, and the second questionnaire included 14 open-ended questions. Forty-five volunteers were found to meet the prior requirements. Of these, all 45 successfully completed the first questionnaire, and 42 completed the second questionnaire. Four key respondents were then selected to participate in semi-structured interviews.

The initial questionnaire was produced using prior literature and peer-debriefing as a guide. We revisited the questions and made changes based on responses provided by a trial group consisting of graduate students in the same science education program. Eventually, a questionnaire emerged and was given to the focus group of participants. After coding the responses, certain answers remained ambiguous. We developed the second questionnaire to clarify views of those factors which have had the greatest impact on opinions of the selected SSI and to further explore student experiences regarding argumentation in the classroom. The intent of both questionnaires was the same with the second set of questions used to clarify the initial responses.

Peer-debriefing was employed at regular intervals to ensure the validity of data and emerging categories. Questions regarding the appropriateness of the selected SSI for the classroom generally required little analysis. For the remaining questions, perspective categories were decided upon prior to administering the questionnaire. During the examination of participant responses, inductive reasoning was employed for the addition of unconsidered categories or the deletion of categories that were not observed. A constant comparative method was used, and the emerging categories were continually revisited as new information emerged from additional responses. Ultimately, all questionnaires were explored in the finalization of an electronic coding manual.

Following an initial examination and development of the emergent categories, all questionnaires were reexamined with each response being summarized under the category it was believed to support. Student responses were compiled into a single, albeit extensive, table. The resulting table included summaries and/or direct quotations from each respondent. Quotations that directly addressed the question and provided supporting criteria or evidence were isolated for possible inclusion in the rich description that was employed to report findings. Our results were interpreted, and themes emerged in light of the prior research mentioned in the theoretical framework. Manuscripts of interviews were produced and coded to produce emerging themes. The interview results were presented as rich descriptions in their own section.

Relevant Findings from the Pilot Study

Various aspects that emerged from the background study were used to inform the current work. The following summarizes the parts that were most useful in the development of the current work.

Feelings regarding the inclusion of SSI in high school curricula. Participants had a general belief that the SSI we selected should be included in the curriculum, but they reached this conclusion for varying reasons. Views of respondents concerning the appropriateness of these topics for the secondary science curriculum are shown in Table 1. We later attempted to identify the underlying components of these beliefs.

Table 1

Beliefs Regarding the Appropriateness of SSI in the Curriculum

Topic	Appropriate	Not appropriate	Undecided	No Response
Evolution	73.3% (33)	22.2% (10)	4.4% (2)	0
Stem Cell Research	53.3% (24)	28.9% (13)	0	17.8% (8)
Climate Change	93.3% (42)	2.2% (1)	0	4.4% (2)

Those respondents who found evolution to be an appropriate topic for high school science classes demonstrated three primary strands of reasoning: practical concerns, a belief in the evidence of evolution, and support for the inclusion of numerous ideas in any discussion of evolution. An example of an argument from a practical standpoint came from the respondent given the pseudonym Amanda who felt evolution should be covered “so when discussing the subject in college, the students will have better knowledge of it.” Responses from participants who were convinced of the validity of evolution as a scientific theory included phrases such as “science based theory.” These individuals did not always expound upon their understanding of the topic. In one open-ended response Kelly wrote, “where I’m from we have a church on every corner. Many didn’t believe it but we do need to touch the subject because it is a science based theory.” Others felt the topic should be included, but as one of multiple possibilities. Lisa wrote, “All ideas should be taught so that kids can be able to understand that everyone doesn't believe the same."

Among those who felt evolution was not appropriate, two broad methods of analysis emerged. We described one of these areas as practical or legal concerns. Kay felt high school students were not mature enough to understand the topic, while Amanda expressed concern over legal issues surrounding the teaching of evolution. The most common reasons cited in opposition to evolution concerned an avoidance of conflicts or a lack of time to fully address all opposing ideas. The reasoning demonstrated by Melinda represented those who believe that the topic of evolution should be avoided to prevent any conflict with current religious beliefs. She wrote "[evolution] could challenge the religious beliefs of an adolescent at the time when they are trying to figure out their religious identity." A similar conflict between religion and evolution was seen in the response from Stephanie: "Creationism can't be discussed so neither should evolution. You can't just teach one side of the story."

Multiple responses made reference to an aversion to the topic of stem cell research due to abortion concerns. These responses regularly used phrases such as "killing babies." Several of the respondents who felt the topic should be included in the high school curriculum supported this belief from a position of pragmatism. Like evolution, these practical reasons included college preparation. The remaining respondents, who felt the topic should be included, were concerned with the development of a fully informed student body. Those expressing this view often emphasized the need for students to be provided the skills necessary for reaching an independent conclusion. Tiffany believes "students should know where the stem cells come from so that they may form their own opinion about the topic." Among those who felt stem cell research should not be taught, a few distinct lines of reasoning emerged. Some participants questioned discussing a topic that remained in flux, while others expressed concern over the usefulness of the topic. Representing those participants who questioned the maturity of high school students, Cassandra wrote, "it is a controversial moral subject that many high school students do not have the maturity to handle." Others felt the topic was simply not a salient use of instructional time.

An overwhelming number of respondents (93.3%) felt that climate change was an appropriate topic for the high school classroom. A number of respondents addressed climate change in an unemotional way, placing the highest priority on the dissemination of information. Katie wrote, "students should have an understanding of their environment." This was contrasted by those who expressed an emotional concern for the necessity of including climate change. For example, Carolyn wrote, "it deals with our future and will affect our lives and the planet." Only one response was negative. Sara wrote, "I believe the discussion may steer some children wrong into thinking the world is going to end."

Personal beliefs regarding SSI. Respondents were asked to describe their views of evolution, stem cell research, and climate change, and participants were instructed to describe their personal beliefs and not their opinions regarding the appropriateness of the topics for the classroom. We attempted to consider the responses in their totality rather than describing them as simply positive or negative. A summary of opinions for each SSI is presented in Tables 2, 3, and 4.

The majority of respondents (52.3%) expressed a generally positive view of evolution. Katie wrote, “I think that learning about evolution is important. Evolution has been proven and the misconceptions can be addressed.” There were, however, reservations on the topic among this group of supporters. Human evolution was one area of concern mentioned by respondents. Nicole wrote, “I feel it is important to teach how we as humans and creatures have evolved over time, but I don’t believe we came from monkeys. I believe God made us and put us here.”

Other respondents felt evolution was a topic with some validity but felt it was only one of multiple valid ideas. Ann wrote, “I view evolution as just another scientific theory; I am not convinced that it is fact. My religious views influence my thoughts on evolution.” A number of responses indicated a complete lack of support for the theory of evolution. In every case these responses expressed an inability to reconcile evolution with Biblical accounts. Jennifer provided one such response: “I think that evolution is not true, that we evolved from Adam and Eve.”

Table 2

Personal Views of Evolution

Positive view	Positive view with some limitations	Neutral view, but should be taught	Equal with other ideas	Negative view	Undecided
33.3% (14)	19.0% (8)	2.4% (1)	19.0% (8)	21.4% (9)	4.8 % (2)

Many respondents felt stem cell research offered great potential for medical treatments, but half of the individuals in this generally positive group expressed some concerns. Melinda only mentioned positive aspects of the practice: “I feel like it can be a very useful tool in trying to find cures or developing methods to help others in need of medical attention.” Bill expressed an openness to support stem cell research but mentioned some concerns. He wrote, “I think that stem cell research could help with the process of obtaining a cure for diseases, but as a disadvantage, embryos are killed. I think that if a positive thing could come out of this research, so be it.”

Some respondents expressed deep concern over the practice of stem cell research. Among these individuals with a generally negative view of the practice, some responses indicated a conflict due to the potential benefits of the research. Nicole provided an example of this opinion, “I think that stem cell research is controversial. I am not sure if I agree with cells being taken from aborted fetuses even if they are used for treatment.” Some participants were not receptive to the practice despite the potential benefit. Unease over abortion remained a universal concern in both of these groups. Donna wrote, “I believe stem cell research is wrong and should not be practiced. I understand it can be helpful and has its advantages, but there should be other means used to obtain these advantages.”

Compared to the other SSI, a larger number of respondents were unwilling to reach a conclusion or gave no answer concerning the topic of SCR. A number of participants expressed a lack of familiarity with the topic. Two respondents reached a conclusion despite uncertainty about fundamental aspects of stem cell research.

Table 3

Personal Views of Stem Cell Research

Positive View	Generally positive, but some concerns	Concerns need to be addressed before it is allowed	Negative View	Unsure	Misunderstanding/ No Answer
23.8% (10)	23.8% (10)	9.5% (4)	11.9% (5)	26.2% (11)	4.8 % (2)

A comparatively small number of respondents were skeptical about the existence of global climate change (14.2%), with half of this group indicating the possibility that their current view could be changed. Stephanie expressed a unique view that did not directly conflict with support for climate change, but she did not indicate any action should be taken to remedy a problem. She wrote, "what is going to happen is going to happen, regardless." Some participants expressed explicit misconceptions about the topic. Two of the responses categorized as misconceptions spoke of global warming in a positive manner. Erica, for example, believes, "global warming is a good thing." Other responses indicated further misconceptions regarding aspects of climate change that prevented students from reaching a definitive conclusion. The slight majority of respondents (52%) expressed an acceptance of the idea and, generally, a feeling that something should be done to correct the problem. Katie appealed directly to evidence she believed to be true, "global warming should be acknowledged because over a period of time it has been proven there are now warmer temperatures in the coldest parts of the world."

Table 4

Personal Views of Global Climate Change

Is occurring	Currently skeptical, but possible change	Skeptical	Unsure	Misunderstanding/ No Answer
52% (24)	7.1% (3)	7.1% (3)	16.7% (7)	11.9% (5)

Impacts on decision-making. On both questionnaires students were asked to describe the major sources of information they used to reach conclusions concerning evolution, stem cell research, and climate change. A summary of these results are shown in Table 5. The findings revealed that school and/or academic sources impact student decisions. The beliefs on SSI expressed by many respondents were influenced by religion. This was especially true regarding the topic of evolution.

Table 5

Primary Sources of Information Impacting Decisions Regarding SSI

Topic	School/ Academic Sources	Religious Influences	Television News Media	Other Media	Family	Friends/other individuals	No Response
Evolution	39.1%	45.7%	0%	8.9%	8.9%	0%	0%
Stem Cell Research	34.1%	15.9%	22.2%	4.5%	4.5%	6.8%	9.1%
Climate Change	46.5%	7.0%	23.3%	7.0%	7.0%	0%	4.7%

Dealing with conflict in the classroom. Multiple participants failed to recognize empirical evidence as the deciding factor in resolving conflicts that arise in the science classroom. In fact, only two respondents touted the benefits of research results. When asked to describe how a science teacher should approach a conflict in subject matter between the majority of the public and the majority of scientists, Chinny wrote, “they should differentiate the two because the public hasn’t done the research, but scientists have.” Joyce was the only student to specifically express a belief that the process used by a teacher to reach a conclusion was potentially of more value than an arbitrary process that could be used by anyone. She wrote “they should discuss why people have different viewpoints and help discuss/describe the way they have developed their own opinion.”

Respondents expressed a belief that avoiding the controversy was a valuable tactic. I have included a summary in Table 6 of how the participants felt these conflicts should be addressed. One of the most common methods described for avoiding or limiting any conflict was for teachers to accept the equality of all opinions. Yolanda felt the teacher "should accept everyone's opinion because everyone is entitled to it, but she shouldn't say or push her own views on the class." Others expressed an aversion to any instruction focused on influencing student opinion. Winnie believes, "They should let students go with their beliefs and their family's beliefs. They should not try to persuade otherwise." Four other methods for reducing conflict were: 1) avoiding the topic completely, 2) making the topic optional, 3) covering the required material in the required manner, and 4) espousing the equality of all opinions. Even when told the topic was "very important" some respondents maintained a belief that the topic should be avoided or made optional. Beverly represented those who did not distinguish scientific theories from other ideas when she wrote, "make sure to tell students that this stuff isn't fact, that it's just opinion or theory." Carolyn described her beliefs in following manner: "They just need to teach the subject without any judgment on it. It never hurts to know about scientific issues because you don't have to agree with them as long as you know what is going on in the world."

Table 6

Respondent's Views of the Most Appropriate Methods for Dealing with Conflicts between Science Content and Opinions of Students and/or Parents

Express scientifically supported view	Avoid the topic	Emotionless presentation of required content	Make the topic optional	Use student debates	Recognize validity of all opinions
17.4%	13.0%	39.1%	13.0%	4.35%	13.0%

Sources of conflict. Four of the participants were chosen to clarify responses through interviews. Students were specifically asked to clarify what they believe to be the primary sources of conflict in the science curriculum, how decisions should be made, and how conflicts should be addressed.

All four respondents held a belief that much of the controversy is the result of conflicts between religion and science. Evolution was mentioned by each interviewee as a source of conflict between science and the public. After describing SSI controversies as being the result of a conflict between individual "beliefs", Lisa, without being prompted to address evolution, said "it's the evolution thing…. It doesn't say in the Bible that God created monkeys and from monkeys the humans. It says God created humans and then everything else." Lisa went on to clarify her beliefs by saying that the Bible and some aspects of "Darwin's theory" do conflict. Nicole also recognized a distinction between science and religion: "There are also religious aspects people believe in, and there is the scientific base people believe in. No one can ever always subscribe to one point." Lacy expressed a belief that conflict between religion and science was the primary reason for controversies surrounding SSI. When asked why she felt controversies exist, she responded:

> Mainly because people think either global warming is not occurring. We were not created from evolution but from divine whatever it is called. Also, the stem cell research we were talking about embryos being humans. We were always taught in my religion that we are created even before sperm reaches egg.

Respondents were asked to clarify their beliefs concerning how decisions regarding controversial scientific subject matter should be made. Interviewees were asked to clarify their understanding of scientific theories and the role of opinion in decision making. All respondents possessed the ability to express a definition of a theory. While the definition may not have been complete, the aspects that were included would be generally accepted by the scientific community. Lisa described a theory as having “been tested and proven over and over again” and opinion as “something you believe but it may not have any factual backing to it, but you believe it.” Nicole voiced an even stronger description of the difference between theory and opinion, “a theory is a proven fact that has been tested over and over, whereas opinion is someone’s thoughts and what they believe.” Lacy said, “opinion is your personal thought or idea which a single person has and can be biased. A theory is scientifically researched by doing scientific methods over and over again by several people to develop a theory.”

Despite having a general understanding of the definition of a theory, students seemed to use the word in a context that indicated something less than fact. Although admittedly not confident in her answer, Lisa said, “we should talk about [science] as a theory, not a fact.” David recognized the differences between opinion and theory, but felt both should play a role in decision making. He said, “you cannot disregard an opinion just because it’s not been proven.”

When asked how school curricula are developed when the subject matter is controversial, a few different ideas emerged. Lisa believes the most important consideration for schools when reaching a decision is the avoidance of conflict. She responded, “schools don’t like confrontation so they try to limit that as much as possible. I think that’s how it is decided. Not based upon…the facts, I don’t know the political thing also.”

Nicole described textbooks and state tests as the biggest drivers for development of school curricula:

> It's in the textbooks now and those teachers teach it because it is in the state test and students have to be able to pass that part to go on in school. So I think teachers will keep teaching it.

Lacy thought it was important that "the teacher is not trying to push the ideas on the students." This limitation placed on the decision-making power of a teacher was a common theme. David extended this limitation to encompass all legislative bodies, stating "I don't think government should be involved in such a big way."

Students mentioned experiences with argumentation that sometimes "got out of hand." This type of experience seemed to have a negative impact on Lisa's willingness to believe an idea accepted by the scientific community: "I thought I believed in that Darwin's theory about humans coming from monkeys because there was so much resemblance and told someone and they got mad at me." Nicole seemed to have a positive experience exploring the different beliefs within at least one high school science course:

> We talked about evolution a lot. People, you know, have different beliefs, and there were different controversies from time to time, a different question sometimes, someone felt differently about an opinion. Each person gave their opinion, we talked about it, and each person presented their case. You may not believe what a person said but we all tried to look at it openly.

All respondents believed that argumentation should be a part of science classes and, if conducted in the proper manner, could enhance student understanding. David said, "the benefits are that you get to see both sides of the controversy. Both the sides may have done some research on what they believe, and you get to see both the sides of the argument."

Every respondent expressed a view that opinions should be subservient to theory when attempting to resolve conflicts of a scientific nature, but consistently expressed a desire to give equal consideration to all opinions in the classroom. When addressing the issue of differences concerning science curricula, respondents consistently and repeatedly expressed a concern for the voicing of all opinions. Lisa described her belief concerning the value of all opinions when she wrote, "I think that people's opinion should be taken into consideration, even though they may conflict, you will have to find a way to balance that out I guess. I understand that everyone's opinion should be heard."

Lacy expressed a belief that even ideas she did not think were scientific should have a place in science classes. She stated creationism should be taught because it was "respectful to other's opinions, [but] I don't think it is a scientific idea." Nicole expressed the benefit open argumentation could have on scientific beliefs:

> I think people should listen to both sides openly. They might adapt to the other person's viewpoint. They may not be educated enough. That might be the problem. You know, just listen to both the sides and present your case well. You may be educating others.

The benefit of argumentation for persuading students to one side of a controversy was not universal. David recalled from his own experiences with argumentation that, "[debates] never changed anybody's opinions, but they got to learn more." Multiple times, interviewees expressed limitations that should be placed on the expression of a teacher's beliefs regarding controversial issues even if those beliefs were grounded in scientific evidence. Lacy stated:

> I believe that I can answer that in relation to global warming, if there is evidence proving what they believe, then they should take a stand but don't push the students to believe in their beliefs but allow them to take their own stand and have their own beliefs.

A desire for the inclusion of all opinions was found among all of those interviewed. This was not necessarily a condemnation of scientific ideas. Nicole said:

> I personally believe that we were created by God, but we have to accept that we have evolved and we are not cave men, we are not hunched over any more. We are evolved and do many things. Even the species have evolved over time. We have to acknowledge the fact that we have evolved.

Conclusions from the Background Study

Participants in this study were generally willing to accept the inclusion of the selected SSI in the science curriculum, but did not necessarily support the underlying scientific ideas. Respondents repeatedly expressed a belief that all ideas should be openly included in high school science courses. Their responses indicated a failure to recognize the value of empirical evidence in decision making when the issue requires that personal beliefs be considered. The limited value respondents place on empirical evidence was further substantiated by some of the sources of information they described as most important. While non-academic sources were found to play an important role, schools and teachers do remain influential in the decision-making process. This may not, however, be an indicator of the effective development of science reasoning skills.

Prior research has stressed the importance of argumentation and its role in the transfer of content knowledge for the purpose of developing socioscientific reasoning skills (e.g., Sadler & Donley, 2006). Despite these purported benefits, our findings indicated limited use of argumentation in the high school science courses taken by our research subjects and, in some cases, a total lack of experience with certain SSI. This lack of experience is likely a limiting factor in the development of scientific reasoning skills on the high school level.

While we did not directly measure students' content knowledge, in some cases an understanding of subject matter did not appear to be the primary limiting factor. The failure to transfer knowledge became acutely apparent in the interviews we conducted. We found students who were able to describe the differences between theory and opinion, but who did not use these ideas in developing their own belief systems. It seems that non-science majors are so concerned with the inclusion of all opinions that there is an ostensible failure to recognize the importance of science based reasoning. Science teachers must be cognizant of the distinction between public opinion and those ideas supported by the scientific community.

Justification of the Study

The beliefs of individual educators, and not variations in curricula, are the primary variable dictating coverage of SSI within the individual classroom (Berkman, Pacheco, & Plutzer, 2008). To explore the beliefs of these individuals an instrument needed to be developed. Prior studies have produced methods that were helpful in the development of such a tool (e.g., Sadler & Zeidler, 2005; Wu & Tsai, 2007), but these studies do not provide a comprehensive examination focused on the opinions of educators. I modified aspects of these earlier studies to produce a mixed method approach for assessing the beliefs of K-12 teachers. Certain aspects of SSI, mainly views of evolution, have been the focus of numerous studies. Other areas, such as stem cell research and global climate change, have seen far less attention. I was unable to find a study that comprehensively examined the opinions of teachers regarding all three of the aforementioned topics.

Decisions regarding SSI are often said to have no definitive solution, and the processes used to reach these conclusions are based on an informal system of reasoning (Zohar & Nehmet, 2002). Content knowledge is an additional factor that is likely to impact the beliefs of individuals, but this relationship is not linear (Sadler & Donnely, 2006). It seems that the basis for belief regarding certain topics is only marginally related to individual understanding of the topic. Levinson (2006a) has produced a framework that is helpful when attempting to identify and explain the divide separating opposing positions regarding socioscientific issues. Many of these decisions have become associated with certain belief systems unrelated to science. Positions related to embryonic stem cell policy and climate change have become associated with political parties and policy changes can be seen with each election (NIH, n.d.; Pew Research Center for the People and the Press, 2009). There is no reason to assume that teachers would be unaffected by such belief systems.

Proponents of SSI often focus on the benefits argumentation can have in the classroom (e.g., Aikenhead, 2000; Driver et al., 2000, Sadler & Donnelly, 2006). Argumentation is also believed to reveal reasoning skill (Acar, 2008) and has been used in multiple studies as a method for evaluating informal reasoning (e.g., Means & Voss, 1996; Sadler, 2004; Wu & Tsai, 2007; Zohar & Nemet, 2002). I incorporated the use of argumentation by asking participants to respond to an issue that was both relevant and current. Aspects of the demonstrated patterns and quality were evaluated in a manner that is fully explained in the methodology chapter of this work. In short, the perspective and quality of arguments has been used to provide insight into the thought process used by the responding educators when reaching conclusions regarding the role of SSI in the classroom.

I hypothesize, based on support in the literature (Donnelly & Boone, 2007), that the personal views of educators are the primary factors influencing classroom instruction when the subject matter is socioscientific and potentially controversial. This study is an attempt to holistically evaluate the beliefs of teachers at all grade levels from kindergarten to senior high school and test that hypothesis. Beliefs regarding SSI could have a great impact on classroom practices (Berkman et al., 2008). The results of this study provide insight into the thoughts of educators and the willingness of these individuals to address SSI within their own classrooms. These results could be used in future attempts to impact classroom practices and possibly benefit in endeavors to improve science literacy.

Delimitations

The focus of this study was on developing a holistic view of educators' opinions regarding potentially controversial aspects of the science curricula. These potentially controversial aspects were taken from selected socioscientific issues (SSI): evolution, stem cell research, and global climate change. To accomplish this task the most sensitive aspects of these topics were identified using criteria found in the literature. Elementary, middle school, high school, and K-12 administrators were all used in this analysis. Active teachers within each of the categories were separated into those who teach science and those who do not.

Participants were not asked to define those aspects of the selected SSI which are controversial and those which are not. This was done prior to the development of the questionnaire using criteria described in the literature. While educators' views of the controversy may have been interesting, such views were beyond the scope of this research. A framing and focusing of the discussion was seen as the most beneficial for comparing variations in opinions regarding SSI in the classroom.

Content knowledge, religious affiliation, church attendance, political affiliation, and political ideology have all been used as factors correlated with certain views of SSI. Responses were compared using these factors as possible indicators of divergent views. Other demographic information, such as size of the community in which the respondent resides, were collected and considered, but the aforementioned variables were the primary focus of my analysis. In addition to their views of SSI in the classroom, participants were asked to provide their personal level of support for the sciences of evolution, stem cell research, and global climate change.

This study focused on the views of educators concerning the inclusion of SSI in the classroom and not the reasoning underlying these conclusions. Such a focus could be a topic for future studies, but was considered too broad to be included. It was also feared that fatigue among participants would prevent a true representation of participant beliefs if such a broad focus was included. This model does include responses to a current issue, which could directly impact classroom practices. Respondents were asked to argue for or against a bill focused on the protection of science instruction, which considers all sides of SSI debates. Responses were qualitatively assessed based on the idea that arguments provide insight into the reasoning modes, patterns of reasoning, and quality of reasoning demonstrated by the respondent. This study is my attempt to evaluate the beliefs of teachers and isolate certain reasons for those variations. In addition, I evaluate the underlying aspects of informal reasoning, which are likely impacting the ultimate conclusions of educators.

Limitations

Participants in this study came mostly from a few specific geographical areas. This was not intentional, but emerged based on those individuals who responded to the survey and questionnaire. In addition, demographic groups were not represented evenly. Caucasians and females were overrepresented among participants. Religion was a focus of the study, but few respondents indicated they attended church infrequently or never; nearly 70% of participants indicated they attended services at least weekly. This high number along with a low number of non-Christians makes conclusions somewhat difficult. The development of the survey also relies upon an assumption that the most controversial aspects of evolution, stem cell research, and global climate change have been selected. Prior literature and the pilot study were used to limit these concerns, but the potential omission of important factors remains a possibility.

Responses to open-ended questions were limited by individual understanding and interest. Since the material described in the questionnaire was both current and genuine in nature, some of the participants may have already been aware of the material. The somewhat subjective nature of qualitative reasoning is another area of possible limitation.

The amount of time that each respondent could devote to this survey was limited; therefore, participants were not asked to complete a survey to evaluate content knowledge. The number of science courses taken was used to measure prior exposure to the information. There are likely many possible variables which would demonstrate a statistically significant correlation with beliefs, but all of the possible factors influencing socioscientific decision making are not likely to be included in any model. The number of covariates that can be used in the statistical analysis is an additional limitation to a comprehensive evaluation. The variables were included and the analysis of results were guided, and possibly limited, by the prior literature.

Assumptions

The assessment tool is assumed to accurately measure the beliefs of the respondents. The preliminary study and prior literature were used as the primary tools for the creation of the multiple-choice evaluation of beliefs. As part of the pilot study, expert evaluation was used to develop a set of open-ended questions. Each of these aspects combined to produce a concise and useful instrument for the assessment of beliefs. It must be assumed that this evaluation tool provides an unbiased and reliable analysis of the true nature of the controversy surrounding SSI in the classroom. Prior studies had evaluated the best methods for evaluating aspects of socioscientific decision making. I used the data presented by this previous research to provide a framework for the development and analysis of my work. The categories used in the open-ended analyses were guided by this prior work.

The value of this research relies on the assumption that the beliefs held by educators have a direct impact on classroom practices and that the employed methods are adequate for isolating and describing differences that do exist. As in all studies, responses must be genuine representations of beliefs or the results are not useful. Several of the respondents completed the multiple-choice component of evaluation tool, but failed to complete the open-ended questions. It is assumed that this lack of response is not an indicator of opinion and that fatigue played no predictable role in the quality of responses. Ultimately, the usefulness of this study relies on the idea that participants in the study provided responses that are accurate and adequate representations of views and these responses are indicative of the beliefs of K-12 educators universally.

CHAPTER II

REVIEW OF RELATED LITERATURE

Arguments in the science classroom are not simply the results of a lack of understanding by one side or the other. Formal and definite aspects of reasoning will not result in predictable conclusions when many socioscientific issues are considered. SSI exist in a realm of reasonable disagreement, where opposing positions can exist with both sides appealing to some form of logic that is not necessarily flawed (Levinson, 2006a). Without the existence of a definitive solution based on empirical evidence, decisions made regarding controversial subject matter are invariably impacted by the ethical concerns of the decision maker (Bryce & Gray, 2004; Ratcliffe & Grace, 2003). Variations in scientific reasoning are unable to fully explain conclusions reached when the issue is socioscientific in nature (Grace & Ratcliffe, 2002), the true explanation lies in a realm which is much less objective. Grace and Ratcliff (2002) were able to show a definitive relationship between selected aspects of science and ethical or religious beliefs. Bell and Lederman (2003) found personal values to play a greater role in decision making than individual understanding of science. Braund et al. (2007) concluded the entire decision-making process surrounding SSI differs from those processes used in reaching conclusions regarding purely scientific questions. Previously held ethical beliefs become an integral part of any attempt to determine how decisions concerning SSI are made. It is very unlikely that decision making in this area is simply a reflection of level of content knowledge (Lee, 2007).

The uncertain relationship between content knowledge and beliefs is perhaps best illustrated when the decision maker in question is among the most educated members of society. Even professional scientists are influenced by beliefs, values, and biases (Lederman et al., 2002), and it is generally accepted that scientists impose value judgments in the decision-making process (Lee, Abd-El-Khalick, & Choi, 2006). Scientists, like all others, are not able to completely eliminate personal belief systems from their research (Rudner, 1998). Separating scientific knowledge from personal belief becomes even more cumbersome when the topic in question involves issues of particular social concern (Abd-El-Khalick, 2003). The moral and personal aspects of socioscientific decision making do not necessarily limit the validity of conclusions; in fact, such types of reasoning may be necessary (Cho & Choi, 1998; Davis, 1999).

In the following literature review, I describe the most important aspects of SSI for the elementary and secondary science classroom. This will include the processes I used to select the focus of my research. Evolution, stem cell research, and climate change emerged as the SSI which seemed most topical and relevant to the science classroom. These topics are particularly controversial and germane considering the role that personal belief plays in the creation of educational policies (Gibson, 2004). The aspects of reasonable disagreement that exist for each of the selected topics have been previously described by other authors and will be discussed in detail later in this work.

While universally relevant, I have isolated the explorations of personal opinions to those ideas held by individual educators. Due to the significant role these individuals play in the delivery of information and the direction of instruction, their opinions are particularly relevant. I searched the prior research for guidance in the development of a method for holistically exploring the views of educators and the underlying reasoning used by these individuals to reach conclusions. While the prior research was very helpful in the development of this work, I failed to find a study that comprehensively examined the beliefs of teachers regarding SSI in the classroom. It is the convictions of these individuals, and not the views of curriculum planners, which have the greatest impact on classroom practices (Berkman et al., 2008).

Describing Socioscientific Issues

Levinson (2006a) provides a helpful framework for identifying socioscientific issues and a summation for identifying the areas of reasonable disagreement. Levinson (2006a) approaches the issue in a manner intended to be helpful for teaching issues within secondary schools. It is argued that knowledge of the subject matter does not and cannot fully explain beliefs regarding socioscientific issues for a number of reasons. Possible explanations for divides in opinion may be the information is overly complex (Thomas, 2000), the science is unsettled or in dispute (Dawson, 2000), and/or the science curriculum is unable to address all of the concerns surrounding the subject (Ryder, 2001). As explained below, I used Levinson's criteria and my own interests to select what I believe to be the most important socioscientific issues impacting the science classroom.

Levinson (2006a) compiled from previous studies a framework for exploring and identifying controversial areas in science teaching. Levinson's work included three primary areas to be used for the identification of controversial issues. First, contrasting sides of the topic approach the debate from fundamentally different premises. These differences include “different key beliefs, understandings, values, or . . . conflicting explanations or solutions that are rationally derived from the premises” (Levinson, 2006a, p. 1204). The second criterion for a controversial issue requires that the beliefs regarding the topic impact a significant number of people. Thus, a small number of individuals with an opinion that diverges from the socially accepted norm are unable to result in a topic being classified as controversial. The third and final criterion presented by Levinson requires that the topic cannot be definitively settled by an appeal to the currently available evidence. Levinson expanded upon an appeal to evidence which had been offered by previous authors (Stenhouse, 1970; Stradling, 1984; Wellington, 1986). The following is a brief summary of Levinson's framework:

1) Contrasting sides of a controversial issue approach the topic from fundamentally different premises. These differences include "key beliefs, understandings, [and] values." The same individuals then "offer conflicting explanations or solutions that are rationally derived from the premises" (Levinson, 2006a, p. 1204).

2) The topic impacts a significant number of people. A specific number is not established, but a small, fringe group is unable to justify the establishment of an accepted SSI.

3) The conflict between contrasting views cannot be resolved by an appeal to currently available content knowledge.

Levinson's criteria make it impossible to appeal exclusively to empirical evidence in resolving scientific question with a social dimension. I used these criteria to identify evolution, stem cell research, and anthropogenic global climate change as three socioscientific issues with a definitive ethical, moral, or religious impact. I will discuss the controversy underlying these topics, but views and the role of these SSI within the classroom are the aspects of these issues that are most relevant to my study.

Aspects of Reasonable Disagreements

Genuine SSI exist as reasonable disagreements, indicating that individuals are able to have diverging ideas without either being seen as unreasonable or extending beyond the realm of acceptable reason. In this system an understanding of reason and the aspects of socioscientific decision making are emphasized. In an attempt to better understand controversial scientific issues researchers have examined the very definition of reason (Dearden, 1981; Levinson, 2006b; Reiss, 1993). Dearden has written: “a matter is controversial if contrary views can be held on it without these views being contrary to reason” (1981, p. 38). It seems apparent that when we make a commitment to one side of an issue we believe our reasons are better than the opposing reasons (Gardner, 1984). Upon initial consideration it may seem illogical to believe that two individuals can reach opposing viewpoints from the same evidence and that those opinions are equally valid (Levinson, 2006a). Within the realm of SSI such a position is not impossible; Levinson (2006a) and McLaughlin (2003) have developed methods for better understanding this conundrum. A nine category system has been used in understanding and framing differences of opinion regarding SSI. I have provided in Table 7 a summary of those categories focusing on the aspects most relevant to the issues of evolution, stem cell research, and global climate change.

Table 7

Levinson’s Categories of Reasonable Disagreement

Category Number	Summary	View of Evidence	Social Aspects
1	Criteria for agreement are accepted, but current evidence is insufficient	Evidence is unambiguous and accepted by both parties	Agreement about how the matter should be settled when evidence is conclusive

Table 7 (continued).

Category Number	Summary	View of Evidence	Social Aspects
2	Criteria for agreement are accepted, but evidence is complex or difficult to assess	Criteria for acceptance of evidence can be agreed upon, but it becomes difficult to determine when/if that criteria have been met	Disagreements concerning certain relevant aspects of the issues and/or the status of the evidence
3	Range of criteria for agreement is accepted, but the weight of each aspect is in dispute	Parties may agree on the evidence that is the best available, but disagree on which aspects are most important	Consensus is only likely after evidence convincingly demonstrates the prioritizing of one form of evidence over another
4	Fundamental ethical differences between. No clear answer as to the criteria that should be used in formulating a solution	Often irrelevant; Possible change in view if evidence changes	Fundamental differences may lead to a lack of substantive communication between parties
5	Agreement about the criteria relevant for judging the issue, but there is a dispute about the proper interpretation or application of one or more criterion	Impact of evidence is limited. Concepts need to be clarified or agreed upon	Conversation is likely, but the terms are issues in need or clarification may be ignored
6	Fundamentally different normative considerations making resolutions difficult	Evidence is complex and difficult to assess	Parties agree the resolution is significant, but unlikely
7	Disagreement about the criteria used in reaching a judgment	Included by Levinson (2006a) as an aspect of category nine	
8	Differences in individual experiences shape the judgment of the parties involved	Evidence is incorporated into the worldview of the individual	Conclusions of parties may be impacted by inherent prejudices
9	No agreement about the framework of understanding used in developing a judgment	Evidence is irrelevant or difficult for the individual to interpret in light of a different framework	Parties are unlikely to find any common ground. Resulting in a lack of substantive dialogue

Levinson (2006a) believes that individual differences can impact the conclusions regarding each of the socioscientific issues I discuss in this work. This is true even when the individual attempts to interpret the evidence in a completely objective manner. Levinson (2006a) specifically mentions issues related to climate change in relation to aspects of categories 2 and 3. In this view there may be a general consensus as to the best available evidence, but the complexity of that material or the most important criteria for reaching conclusions makes a solution elusive. Issues related to embryonic stem cell research are placed in categories 4 and 5. This suggests the evidence plays some role in reaching a conclusion, but evidence becomes subservient to beliefs surrounding the most important criteria for decision making. Finally, Levinson (2006a) places evolution into category 9; in which the framework that has been shaped within the individual and evidence becomes largely irrelevant. Using Levinson's model it becomes clear that multiple factors must be explored when considering how decisions are reached regarding socioscientific dilemmas.

Selected SSI in the Classroom

Like many SSI, evolution, stem cell research, and climate change are topics of interest among individuals ranging from professional scientists to those with only a passing interest in most science topics. Aspects of these controversies have spilled over into the classroom. This is especially true for the topic of evolution, which has been the focus of legal battles in the United States for nearly a century. Before I could develop an instrument that could measure opinions regarding the most concerning aspects of the selected SSI, I found it necessary to better understand current and historical beliefs. In the remainder of this section, I will explore in greater detail the specific aspects of each SSI that have been debated among the general public and within the classroom.

Evolution in Education

Teaching of evolution has a long history of societal conflict. Battles in Pennsylvania and Georgia in the past ten years and recent concerns over the textbooks used in the state of Texas make the topic exceedingly relevant (Armenta & Lane, 2010). Recent Gallup polls (Newport, 2009) found that only 39% of respondents were willing to say they believed in evolution. Almost as many individuals, 36%, had no opinion as to the validity of the topic. The number of those who did not believe in evolution or who had no opinion was largest among those who regularly attended church and those who had a high school education or less. Polls have also shown a growing number of individuals who believe ideas which oppose evolution should be included in the science curricula (Berkman & Plutzer, 2010). The trend opposing this particular scientific idea makes evolution an area of particular concern among science educators.

Scientists feel free to make strong and conclusive statements concerning the validity of evolution and believe the topic to be of the highest importance. Even with strong and prevalent beliefs among the scientific community, a large number of students leave school with “little scientific understanding of evolutionary processes” (Cavallo & McCall, 2008, p. 522). This trend is unlikely to be corrected as long as those individuals who oppose evolution continue to make decisions within a large number of classrooms.

Legal battles have typically culminated in rulings which upheld the teaching of evolution, while preventing the teaching of any religious based alternative (Berkman et al., 2008). The first, and possibly most well-known case involving evolution, did not result in such a ruling. In this instance, the Tennessee Supreme Court upheld the constitutionality of the Tennessee Anti-Evolution Act of 1925 (*Scopes v. State*, 1925).

The court's ruling upheld the conviction of John Thomas Scopes in the famous Scopes monkey trial. This law prevented teaching the idea that man descended from a previous species and was not a direct creation of God as described in the Bible (University of Missouri Kansas City Law School, n.d.).   A clear trend in favor of the teaching of evolution emerged later when the highest federal court finally addressed the legality of the practice in 1968 (Berkman et al., 2008). In *Epperson v. Arkansas* (1968) the U.S. Supreme Court officially made the establishment of any law prohibiting the teaching of evolution a violation of the Establishment clause found in the First Amendment to the United States' Constitution. The Supreme Court found that the aforementioned Tennessee law had been based solely on the beliefs of Christians, who held the principles of evolution were a violation of their religious beliefs, and that an anti-evolution law based on such beliefs was tantamount to an act promoting the "establishment of religion," which is prohibited in the First Amendment (*Epperson v. Arkansas*, 1968).

Following the *Epperson v. Arkansas* (1968) decision, believers of creation science began to use a different tactic to reduce the impact of evolution in the classroom. Supporters of creationism began to promote the establishment of a science curriculum that included aspects of both creation science and evolution or one that emphasized a lack of conclusive evidence supporting the validity of evolution. In *Daniel v. Waters* (1975) the United States Court of Appeals, Sixth Circuit heard one such statue implemented by the state of Tennessee. In this case a state law required that any text used in public education which addressed the origin of humans must include a disclaimer; this disclaimer was to emphasize the questionable validity of scientific theories and present an equal emphasis on the creation of humans as described in the Bible. This law was ultimately declared unconstitutional under the First and Fourteenth amendments of the U.S. Constitution (*Daniel v. Waters*, 1975). This ruling did not stop similar attempts by state legislatures, and in the U.S. Supreme Court was obligated to rule on a similar law passed by the state of Louisiana. In 1987, the U.S. Supreme Court upheld an appeals court decision against the constitutionality of the Louisiana "Creationism Act" (*Edwards v. Aguillard*, 1987). This law forbade public elementary and secondary schools in the state from teaching evolution unless accompanied by "creation science."

In a 1971 case, *Lemon v. Kurtzman*, the U.S. Supreme court established a set of criteria that has been used in cases regarding the establishment of laws surrounding the teaching of evolution and creationism. A three part system was used to determine if any statute is a violation of the clauses in the First Amendment, which prevents the establishment or support of a single religion. First, the law must have a secular purpose; second, the law must not be intended to advance or inhibit a religious position; and finally, the law must not require the excessive entanglement of church and state (*Lemon v. Kurtzman*, 1971). *Kitzmiller vs. Dover Area School District* from 2005 is a more recent federal court ruling which employed the "Lemon test" for a decision regarding the evolution-creation debate. In this instance, the United States District Court for the Middle District of Pennsylvania was asked to rule on the constitutionality of a resolution imposing limits on the teaching of evolution (*Kitzmiller v. Dover Area School District*, 2005). The Dover School Board required biology teachers to read a statement that expressed the limits of evolutionary theory while also emphasizing the possibility of alternative ideas. In their defense the school board made no mention of a religious influence, instead questions regarding the origins of life were to be left to the beliefs of individual “students and their families” (*Kitzmiller v. Dover Area School District*, 2005, p. 2). The district court found the requirement in violation of the “Lemon test,” and found that those ideas that oppose evolution are religious based (*Kitzmiller v. Dover Area School District*, 2005).

In the view of most scientists, those who encourage limitations on evolution in favor of any alternative ideas are being dishonest or are relying on a religious faith not founded in scientific principles (Berkman, Pacheco, & Plutzer, 2008). The issue of evolution has become so important to certain religious groups that it has been credited as a primary factor in the origin of fundamentalist ideas (*Kitzmiller v. Dover Area School District*, 2005). The National Academy of Sciences (NAS) also views evolution as fundamentally important. The NAS has promoted evolution as the primary unifying principle of the life sciences (National Academy of Sciences, 1999). Support for the national coverage of evolution in school can be found in the curriculum recommendations of three major groups: the National Research Council (1996), the National Science Teachers Association (1992), and the American Association for the Advancement of Science (1989).

It seems that attempts to include evolution in state science curricula have been largely successful. Rutledge and Mitchell (2002) found that variations between states can account for no more that 11% of the variation in coverage among science teachers. Similarly, a study by Berkman et al. (2008) found that 90% of variations in the amount of time teachers spend on evolution are the result of variations within states and not between states. The beliefs of the individual teacher, and not the state curriculum, seem to have the largest impact on actual instruction.

Levinson (2006a) found that the evidence surrounding evolution is conclusive and that there is a disagreement surrounding the framework that should be used to make judgments. The conflict surrounding evolution is primarily a battle pushed by proponents of fundamentalist Christianity (Leinisch, 2007; Ruse, 2005). Thus, framing the issue requires an understanding and literal interpretation of Biblical text. The Bible states “on the seventh day God was finished with the work he had been doing” (New American Bible, 1990, p. 5). The literal interpretation of this has resulted in a belief that the Earth developed very quickly and is very young. Similar analysis of passages describing the development of all animals in a single day and the creation of man in God's “divine image” (New American Bible, 1990, p. 5) may be an additional support for those who oppose evolution. An examination of Biblical texts using the previously described framework precludes a belief in a lengthy process of evolution and speciation. Based on the historical context, an examination of beliefs regarding evolution requires some consideration for the religious views of the individual. There is no reason to assume that the religious perspectives of teachers would not have a similar impact on their acceptance of evolutionary ideas.

Ethics of Stem Cell Research

Many researchers believe that embryonic stem cell research possesses enormous possibilities for the development of medicines and other medical treatments (Latham, 2009). The acquisition of embryonic stem cells often involves the destruction of early-stage human embryos making the research difficult for many individuals to embrace (Latham, 2009). A Gallup Poll from May 2010 found that 59% of respondents believe that embryonic stem cell research is morally responsible, with an additional 3% believing the practice could be morally responsible in certain situations (Gallup, 2010). In a somewhat contradictory result, a survey by the BBVA Foundation concluded that the majority of United States citizens place the rights of embryos above the medical benefits that may be developed from the research (Fundacion BBVA, 2008). This group found that a lack of conceptual understanding regarding stem cell research was prevalent (Fundacion BBVA, 2008). It is possible that this lack of knowledge is influencing the consistency of opinions regarding stem cell research.

Probably the most visible discourse over the ethics of SCR has come directly from the statements and executive orders from the current U.S. President and his immediate predecessor. An order from President George W. Bush on August 9, 2001 limited the embryonic stem cells that could be used in federally funded research (National Institutes of Health [NIH], 2009). In short, this order limited federal funding of embryonic stem cell research to lines created before 9:00 pm EDT on August 9, 2001. In addition, the stem cells must have been donated by consent of those who provided the gametes, and the embryos must have been created for the purpose of reproduction, but were no longer needed. The use of stem cells in medical research was further clarified by President Bush in Executive Order 13435. This order emphasized the need to establish moral and ethical bounds surrounding SCR. The order specifically states "the destruction of nascent life for research violates the principle that no life should be used as a mere means for achieving the medical benefit of another" (Executive Order No. 13435, 2007, p. 34592). The order goes on to describe embryos as "living members of the human species" and "not raw materials to be exploited or commodities to be bought and sold" (Executive Order No. 13435, 2007, p. 34592).

Executive Order 13435 did not alter the previously mentioned limitations on funding for embryonic stem cell research, but it did serve to expand the federal funding of research using stem cells that did not come from or would ever result in human embryos. On March 9, 2009, President Obama issued Executive Order 13505, which sought to overturn the limitations on embryonic stem cell research put in place by his predecessor (Executive Order No. 13505, 2009). This order was, however, overturned by a federal court in August of 2010 (Harris, 2010).

Hans-Werner Denker (2008) has provided a one sentence summary of the most basic ethical question surrounding stem cell research: "whether we should see in an early mammalian embryo (a morula) more than just a cluster of cells" (Denker, 2008, p. 252). A biological solution to the ethical dilemmas surrounding ESCR has been proposed. Denker devised a test to be used in the determination of the potential capabilities of stem cells prior to use in medical research (Denker, 2008). In short, those stem cells with the potential to differentiate into a basic body plan are not appropriate for medical research and those that do not have the potential for these basic tasks would be appropriate entities for medical research. This does not preclude the use of techniques which would artificially limit the abilities of those embryos before being tested. Soren Holm (2008) admits that such ideas are attractive, but many methods, such as those described by Denker, merely reflect an unwillingness to make moral and political decisions.

In the broadest definition, a human embryo begins immediately after fertilization of the egg and extends until all of the major body structures are present (Moore & Persaud, 2003). This development may take as long as ten weeks, at which point the embryo is described as a fetus (Reiss, 1998). Holm (2008), in support of those who believe an embryo has a certain moral status, writes, “[fetuses] are not much more morally important than embryos” (Holm, 2008, p. 259). In addition, these individuals do not see an important distinction between embryos that stop dividing after four days and those which stop dividing closer to becoming a fetus (Holm, 2008).

Intrinsic objections to the practice of SCR have had policy consequences concerning the funding of the research (Presidential Commission for the Study of Bioethical Issues, 2010). It is unlikely that these intrinsic objections will be resolved solely by an appeal to scientific evidence or empirical explanations. President Barack Obama recently established a panel to address bioethical concerns surrounding synthetic biology (Presidential Commission for the Study of Bioethical Issues, 2010). One recommendation from this panel was an increased focus on bioethics in education. While not specifically mentioned, the intrinsic ethical concerns of synthetic biology seem to overlap with the concerns regarding embryos in medical research. Values and public policies that were in existence prior to the emergence of ESCR have converged to impact the current policy of medical research funding (Latham, 2009) and subsequent educational policies. While attempts to circumvent the problem may be appealing, it seems that even a tenuous resolution requires an examination of ethical and moral beliefs related specifically to this field of research.

Questions surrounding embryonic stem cell research have little to do with an interpretation of evidence. Instead, the primary area of disagreement concerns ethical questions regarding the rights of embryos versus the benefits that might be produced for post-natal individuals. The literature presents instances of educators who are wary of including ethical considerations within science courses (Hodson, 2003; McGinnis &

Simmons, 1999; Sadler, Amirshokoohi, Kazempour, & Allspaw, 2006). Despite this purported unwillingness to include personal biases, the impact of teacher beliefs has been shown to exist. Numerous researchers have independently concluded there is a relationship between teacher beliefs and practices with the eventual learning outcomes of the students becoming apparent (Bryan & Atwater, 2002; Haney, Czerniak, & Lumpe, 1996; King, Shumow, & Lietz, 2001; Lederman, 1992; Tobin & LaMaster, 1995). In some instances a national curriculum has been adopted that specifically includes the ethical implications of socially relevant and potentially controversial science topics (Bryce & Gray, 2004). Despite being a factor in decision making regarding SSI, the inclusion of ethical questions within science classes remains inconsistent.

Beliefs concerning the ethics of ESCR cannot be answered by an appeal to empirical evidence (Levinson, 2006a). The basic controversy regarding stem cell research is likely one concerning the right to life or, specifically, the rights embryos have to life (Holm, 2008). There is no valid reason to believe that those who oppose embryonic stem cell research are less empathetic towards sick adults. Empirical evidence may, however, be used in assessing views regarding the possible outcomes from using embryos in research. Those who oppose the use of embryos may be less convinced of the positive impacts of medical treatments. New and emerging technologies which allow for the development of embryos from alternate sources, such as induced pluripotent stem cells, are altering the course of the debate. While these alternative sources are becoming available, the desire for embryonic stem cells in research remains (Hyun, 2010). The future of ethical concerns surrounding this topic seems to exist in the transition from the laboratory to the clinic (Hyun, 2010). At some level, the debate remains cemented in the appropriate treatment and possible manipulation of the most fundamental aspects of human life. Debates over the treatment of embryos are only part of a larger conflict focused on definitions of life and the protection of these living pieces.

Anthropogenic Causes of Global Climate Change

Researchers currently feel free to make definitive and unequivocal statements concerning climate change. For example, a 2008 publication in the *American Journal of Preventative Medicine* stated, “humans are now unequivocally implicated in triggering global climate change, and the impacts on human and natural systems will be severe, far reaching, and affect the most physically and economically vulnerable people around the world disproportionately” (Semenza, Hall, Wilson, Bontempo, Sailor, & George, 2008). Despite the definitive nature of the previous statement, a public controversy still exists. A Pew Research poll from 2009 found the United States may be more divided than ever concerning the topic of global warming. Fifty-seven percent of those surveyed felt there was “solid evidence” to support global warming, but only 36% felt that human activities were a major cause. Additionally, only 35% were willing to describe the problem as “very serious.” Each of these numbers was lower than a similar poll taken by the same organization 18 months prior.

From the previously cited Pew Research poll, the least support exists for the idea that humans are responsible for climate change. The scientific consensus seems to support a conclusion that climate change is occurring, that it will have a significantly negative impact, and that humans are largely responsible for the emission of pollutants that are leading to the problem (Intergovernmental Panel on Climate Change [IPCC], 2007). In the light of conclusive statements from organizations such as the

Intergovernmental Panel on Climate Change, it might seem that those opposing climate change exist outside of Levinson's (2006a) description of a “reasonable disagreement,” but many aspects of the climate change controversy do not exist beyond logical differences of opinion (e.g., Bennett, 2010).

Deniers of climate change do not exist entrenched in a belief system that cannot be altered. Bennett (2010) was able to demonstrate a significant change in views regarding climate change following a brief intervention, which included explanations of the available data. Scientific and technical information used in support of climate change may have only a limited impact in persuading individuals to accept the existence of human induced climate change (Filho, 2009). The overwhelming amount of data may lead to an information-overload, preventing the presentation of data from having the desired impact. The data is so complex that professional scientists must edit the information, and acceptance of this abundant evidence requires that those charged with interpreting the material be universally trusted. The interception of email correspondence between certain climate scientists suggests that, in some instances, morally questionable practices may have been used in order to present to the public a more conclusive result (Eilperin, 2009).

Levinson’s (2006a) criteria require that SSI be examined within the context of shared moral sensibilities. Deceitful practices, such as the skewed interpretation of available data or the denial of climate change for personal gain, are not considered a genuine aspect of a socioscientific controversy. Dan Kahan of the Cultural Cognition Project at Yale Law School offers a summary of the problem based on variations in cultural values, and not scientific evidence (Kahan, 2010). Socioscientific controversies may be the result of diverging theoretical frameworks used to formulate opinions from the available evidence (Levinson, 2006a). It seems that the acceptance of the evidence used to support beliefs surrounding anthropogenic climate change may be the result of widely diverging views that extend well beyond science.

Purdy (2010) discusses an idea focused on the lack of proven actions available to combat climate change. There may be an unwillingness to take immediate action due to a belief that the current generation may be negatively impacted, while the benefit to future generation is uncertain (Purdy, 2010). Filho (2009) has supported the view that individuals need to believe they have an impact and that discussion of climate change needs to be focused on realistic solutions. The idea exists that solutions proposed by political leaders, such as “cap-and-trade,” unfairly hurt the U.S. economy (Merrill & Schizer, 2009, p. 29) Those opposed to the proposed actions argue that some 95% of the benefit from U.S. action will be felt by those outside of the country (Purdy, 2010). Some believe the United States economy will suffer relatively little direct, long-term impact from climate change with only a 0-3% decline in GDP being experienced within the country (Nordhaus, 2008). Those opposing this prediction find such estimates fail to fully consider the interconnectedness of the world’s economies (Freeman & Guzman, 2009). It remains, however, that the lack of focus on climate change and the lack of willingness to accept the apparent scientific consensus may be greatly influenced by the lack of a solution that is acceptable to the economic interest of the United States and a lack of certainty regarding the overall benefits of any proposed action.

Brofenbrenner (1979) developed an idea related to scientific literacy, which he labeled a macrosystem effect. The macrosystem effect is a belief that awareness of an issue is the result of multiple aspects of the society, with school being only one part of this larger structure. An extensive study examining the beliefs of students in Australia and the United Kingdom found evidence of this structure in relation to climate change (Boon, 2009). It was found that the bodies regulating science curricula generally accepted the inclusion of climate change from the perspective described by the majority of scientific entities (Boon, 2009). Even when implemented within school science classes, such beliefs from prominent science bodies may not be directly reflected in the science curriculum (Coffield et al., 2007). It seems that multiple outside sources are impacting the conclusions of the general public.

The media contains both those in support of actions to prevent climate change and those opposed to the implementation of these practices. These information sources often add to the uncertainty surround climate change. Purveyors of popular media are typically presented with beliefs without a presentation of the underlying data supporting potentially controversial claims (Boon, 2009). In an attempt to remain neutral, newspapers or television reports often present scientific aspects of climate change as being unsettled, even if a consensus has been reached by the scientific community (Dispensa & Brulle, 2003). It is also believed by many that popular media exists in an environment which supports those industries that could be hurt if action is taken to limit greenhouse gas emissions (Nissani, 1999). The perceived uncertainty is likely to contribute to a public which is both confused and apathetic (Dispensa & Brulle, 2003).

The length of time typically mentioned when discussing the projected impacts of climate change is often so far in the future that many do not believe immediate action is necessary (Stanwell-Smith, 2007). Teachers have been of little help in understanding the debate, due to the lack of knowledge demonstrated by many educators (Hansen, 2003). All of this culminates in a seemingly uninformed and often unconcerned general public. Some reform advocates argue that a more systematic effort which incorporates all facets of society is needed to increase understanding and promote action to prevent climate change (Roth, Tobin, & Ritchie, 2008)

Anthropogenic climate change is an SSI which exists less in the ethical realm than the previously mentioned issues. There is no compelling evidence to suggest that otherwise reasonable and responsible people would not support protections to sustain life on the planet if they felt climate change was a real problem. Scientists would likely argue that enough evidence currently exists to support the idea that the climate is changing and human pollution is a major cause of this change. The complexity of available data (Filho, Pace, & Manolas, 2010) or the lack of a compelling resolution to the problem (Purdy, 2010) may be limiting the willingness of individuals to accept available evidence. Until a concise explanation and path to resolution are developed, many people may be unwilling to support actions they fear will hurt the economy. The real conflict may not be in the acceptance of the existence of climate change, but in the differences between those who support environmental action and those who are not yet convinced these actions are necessary or will be helpful.

Socioscientific Decision Making

In understanding any decision-making process two broad categories of reasoning emerge: formal and informal. Formal reasoning methods depend upon logical and mathematical concepts and the processes of induction or deduction (Sadler, 2004). Sadler (2004) argues that the results of formal reasoning are fixed and unchanging.

Aspects of science are often presented in the context and language of formal reasoning, but the underlying origins are likely the result of an informal system of thought (Tweney, 1991). Socioscientific issues are a distinct example of topics which cannot be subjected to an unyielding and purely mathematical decision-making process (Wu & Tsai, 2007). In these instances some process of informal reasoning becomes the only reasonable method for decision making.

Kuhn (1993) argued that formal reasoning does contribute to scientific discovery, but in Kuhn's vision of theory change it becomes very likely that informal reasoning often plays a more prominent role (Kuhn, 1993). The changing nature of information and evidence surrounding SSI presupposes shifts in reasoning will occur as new information becomes available (Perkins, Farady, & Bushey, 1991). According to Dearden (1981), it is necessary to consider informal reasoning in any instance where opposing sides disagree while neither exists in a realm contrary to reason. The topics appropriate for informal reasoning often lack a definitive solution or the solution is not possible considering currently available data (Sadler, 2004). The informal solutions that result are often expressed or received as judgments related to what should be believed or what should be done (Shaw, 1996). In these instances it is not possible to produce a single solution that is solely supported by all available empirical evidence. Either the collected evidence to support a single solution remains unclear or other solutions are also supported by the available evidence.

When exploring the controversy surrounding evolution, stem cell research, and climate change informal processes seem most important. Sadler (2004) has identified the primary aspects of informal reasoning regarding SSI as revealed through a review of literature. The areas that emerged were socioscientific argumentation, the relationship between nature of science conceptualizations and socioscientific decision making, the evaluation of information pertaining to socioscientific issues, and the influence of conceptual understanding on informal reasoning. I applied these ideas in my exploration of the views of educators using the following categories: 1) conceptual understanding, 2) views of evidence, 3) social influences, and 4) representations of informal reasoning.

Conceptual Understanding

The impact of content knowledge on beliefs regarding SSI continues to be an area of interest among science education researchers. A lack of understanding regarding science concepts produces an impediment to reasoning ability (Fleming, 1986; Tytler, Duggan, & Gott, 2001). Views and interpretations of evidence have been shown to be a major factor in describing differences of opinion (e.g., Levinson, 2006b). For matters settled among the scientific community, the relationship between content knowledge and decision making is linked to the ability of the individual to interpret empirical evidence. High school students often demonstrate a lack of understanding regarding the most basic interpretation of scientific data (Sadler, Chambers, & Zeidler, 2004). Thus, some individuals lack the most fundamental tools necessary to form a cogent opinion regarding controversial, science-based subject matter. Despite a seemingly logical correlation, a direct relationship between content knowledge and an understanding of SSI remains elusive (Sadler & Zeidler, 2005).

Kesselman, Kaufman, and Patel (2004) explored the application of content knowledge in relation to beliefs regarding HIV. Participants consisted of middle and high school students who were asked to evaluate the validity of scenarios which contained myths regarding HIV. Participants' responses were analyzed based on the demonstrated level of understanding of biology and their ability to identify myths in the aforementioned scenarios. Students with a more advanced understanding of biology were generally better at identifying incorrect ideas. These individuals were found to reason in identifiably different ways. In this instance, a more advanced system of reasoning was reflected by those participants who incorporated cellular aspects of life in their responses. Kesselman et al. (2004) is significant in its qualitative identification of more advanced reasoning systems employed by those with greater content knowledge.

Wynne, Stewart, and Passmore (2001) offer evidence similar to that brought by Kesselman et al. (2004). Wynne et al. (2001) asked high school students to apply their current understanding of meiosis to genetics problems. The requirements of participants included the formation of original explanations from anomalous data. The authors eventually concluded that some students were applying knowledge in complex ways. The works of Kesselman et al.(2004) and Wynne et al. (2001) provide insights into the application of science knowledge, but they do not deal specifically with socioscientific issues. SSI are unique given the possibility that a single correct answer is often illusive.

Sadler and Zeidler (2005) provide a study which deals directly with SSI, specifically, genetic engineering. Two hundred and sixty-nine students were asked to complete a quantitative test to assess understanding regarding genetics concepts. From this original sample a group of 15 low performers and a group of 15 high performers were identified. Each member of these divergent groups was interviewed. In these interviews students were asked to produce arguments related to gene therapy and cloning scenarios. Sadler and Zeidler (2005) concluded that those with a greater understanding of science concepts were able to incorporate content into their arguments in more appropriate ways.

Sadler and Donnelly (2006) propose that a relationship between content knowledge and reasoning may be present, but the relationship may not be linear. Specifically, 56 high school students were asked to complete an examination to assess content knowledge related to genetics. These participants were then interviewed to assess argumentation quality, including the application of content knowledge. This study was unable to produce statistically significant results, but the "Threshold Model of Knowledge Transfer" did emerge to explain this lack of a definitive relationship (Sadler & Donnelly, 2006, p. 1463). In the proposed model, certain thresholds of content knowledge may be more important in describing the relationship between knowledge and application of that knowledge. The lowest informed members of the population may have such limited understanding of a topic that the meaning of the question is lost, the next group would have an understanding similar to what is presented in high school or introductory college biology courses, and the final group would have a knowledge content required of successful biology majors (Sadler & Donnelly, 2006). In the vision of Sadler and Donnelly (2006), ill-defined levels of content knowledge become primarily important when attempting to identify a relationship between content knowledge and argumentation quality.

Other studies support the idea that relationships between content knowledge and beliefs can be most easily observed in widely divergent groups. These include comparisons of reasoning between middle school students and college professors (Hogan, 2002), and a measure of reasoning differences between high school and college students

(Zeidler et al., 2002). It is plausible that the difficulty in relating content knowledge to reasoning may only become clear if something similar to the "Threshold Model of Knowledge Transfer" is employed.

Attempts to relate views of SSI to content knowledge assume that greater levels of understanding will lead to a greater acceptance of one idea over another, but in some instances a single conclusion is not available (Dawson, 2000). Sadler (2004) describes science as a discipline that relies on empirical evidence, but when addressing socioscientific issues the data must be interpreted in a creative fashion. Ultimately, the role of content knowledge in SSI decisions is a question of how knowledge is transferred in the decision-making process (Sadler & Donnelly, 2006). Some have suggested that knowledge can be transferred in sophisticated ways (Kesselman et al., 2004; Wynne et al., 2001), and describing these complex transfers of knowledge may be difficult. Understanding the transfer and ultimate application of knowledge often requires an exploration of ethical and/or moral aspects underlying scientific decisions (Sadler, 2004). While the direct relationship remains unclear, those with greater content knowledge are more likely to have a more positive view of SSI (Topcu, 2010). It is possible that this relationship is simply a natural result of the inclination of the individual decision maker and not indicative of a greater level of understanding.

Views of Evidence

Individuals may exclude scientific knowledge from decision making when the topic is socioscientific in nature (Sadler, 2004). A larger field of study referred to as the Nature of Science (NOS) encompasses views of science and understandings of the epistemology of science (Sadler, 2004). The study of NOS in relation to informal reasoning relies on the idea that understandings regarding the epistemology of science influence the patterns of reasoning used to make decisions. Bell and Lederman (2003) attempted to describe the relationship between views of science and SSI decision making. Participants who had all earned doctorate degrees in a variety of fields responded to a questionnaire designed to assess their views of the nature of science. These same individuals responded to scenarios involving fetal tissue implantation, global warming, the relationship between diet and cancer, and the relationship between cigarette smoking and cancer. The conclusions that emerged were generally political in nature. Bell and Lederman (2003) found divergent views of the nature of science, but were unable to relate these to conclusions regarding these socioscientific questions. It was concluded that empirical evidence was not the primary factor in the decision-making process (Bell & Lederman, 2003).

Zeidler et al. (2002) conducted a study addressing the appropriateness of animal research. Data were collected concerning the general view participants held regarding the nature of science and the views of individuals specifically related to animal research. Students were then exposed to data inconsistent with their personal views and asked to respond. This study found that students were often willing to change their opinions regarding the appropriateness of animal research and views of the nature of science rarely impacted decision making. When presented with data inconsistent with their personal beliefs, some respondents expressed a concern that outside influences play a role in data collection and interpretation. This unwillingness to accept the validity of data was used to justify previously held opinions, and views of science were subservient to other factors in the decision-making process (Zeidler et al., 2002).

Sadler et al. (2004) conducted a study exploring the views high school students held regarding global climate change. The participants consisted of average and below average performers. Students were asked to read contrasting reports related to the existence of global warming. Students were then asked a series of open-ended questions concerning their views of the underlying science. Many of the students were unable to deal effectively with data, and it was concluded that students tended to support views consistent with their previously held opinions (Sadler et al., 2004). This trend held true for 40% of students who preferred articles that supported their previously held opinions of climate change, even if they found the scientific content less reliable (Sadler et al., 2004).

Lewis and Leach (2006) conducted a study using over 200 students between the ages of 14 and 16. Students were asked to provide arguments and supports related to gene technology issues. Some level of scientific understanding was necessary to do this effectively, and some participants were unable to identify key issues related to the SSI they were asked to discuss. The necessary knowledge base was limited and could be easily supplied with modest, effective instruction. The work of Lewis and Leach (2006) lends support to an idea that some level of content knowledge is necessary to identify and use the available evidence. This necessary level of understanding may, however, be minimal.

Evidence clearly plays some role in decision making, but different individuals may use and rely on different forms of evidence when reaching conclusions regarding SSI. In a case study concerning a local environmental issue, Tytler et al. (2001) propose three aspects of evidence which may emerge from the same data. The first type of evidence is formal scientific evidence. This evidence is based on an empirical examination of evidence and personal bias is limited as much as possible. The second type of evidence is informal. This type of evidence is based on common sense or personal experience. This may not contradict with formal evidence when formal evidence is not available to fully support a single opinion. The third type of evidence concerns wider issues impacting one's view of the data. These concerns may be practical and could possibly be expressed in the form of questions regarding the validity of data based on real-world concerns.

Bell and Lederman (2003) found other informal factors, which outweighed the influence of NOS in the decision-making process, and these outside influences are likely to impact one's view of evidence. There is a willingness among some individuals to dismiss evidence that is credible if it disagrees with previously held opinions (Sadler et al., 2004). This suggests that the role of science in socioscientific dilemmas may be difficult to assess. Influences that are not empirical in nature may be of primary importance in the decision-making process.

Social Influences

There is a tendency among many individuals to separate content knowledge and empirical evidence from personal belief; some individuals completely separate the two ideas when making decisions concerning SSI (Zeidler et al., 2002). In instances where each side is honest and an appeal to empirical evidence is not possible, one must examine the reasons for the disagreement more closely. Moral, personal, and social values may serve as the primary factors in decision making surrounding numerous topics (Bell &

Lederman, 2003). Yang and Anderson (2003) have found evidence that the extent to which individuals use social or scientific sources varies from person to person.

Personal beliefs are thought to impact the way individuals reach decisions regarding socioscientific questions (Sadler & Donnelly, 2006). Certain personal beliefs have been identified as impacting individual's thoughts on evolution, stem cell research, and global climate change. The affiliation of individuals to certain social institutions has been used to identify variations in belief systems. The role of religion and evolution is well documented (Leinisch, 2007; Ruse, 2005). The affiliation of individuals to selected social institutions is a common aspect of many opinion polls focused on views of evolution, stem cell research, and global climate change. For example, when evaluating views of these topics The Pew Research Center consistently asks questions regarding political and religious affiliation. These polls have shown a notably lower acceptance of human evolution among Muslims and certain Christian groups as compared with Buddhists, Hindus, Jews, and unaffiliated individuals (Masci, 2009). Jehovah's witnesses, Mormons, and Evangelical Protestants were especially unlikely to accept science based ideas related to human evolution.

The debate surrounding stem cell research has been described as a right to life issue (Holm, 2008). The debate becomes more complicated, however, when the balance between the rights of the embryo are compared with potential medical benefits that could result from this research. Despite this complexity, some trends have emerged. Democrats and Independents are more likely to support ESCR, while Evangelicals are less likely to support stem cell research as compared to other Christian groups (Masci, 2008). A lack of support for research using embryos was especially noteworthy when the individual regularly attended church services.

Political affiliation has been seen as a factor related to the acceptance of global climate change (Pew Research Center, 2009). Legislation such as “cap-and-trade” has a definite relationship to politics (Merrill & Schizer, 2009, p. 29). Independents and especially Democrats have been found to be more accepting of global climate change as compared to their Republican counterparts (Pew Research Center, 2009). Religion and politics have been used consistently as factors highlighting differences in opinion related to evolution, stem cell research, and climate change.

Representations of Informal Reasoning

One’s ability to develop an argument corresponds with one’s understanding of the given subject (Sadler & Zeidler, 2005). The belief that understanding can be revealed through argumentation has led to the use of argumentation as a method for evaluating informal reasoning (Means & Voss, 1996; Sadler, 2004; Wu & Tsai, 2007; Zohar & Nemet, 2002). Sadler and Zeidler (2004) have identified two uses of argumentation in the assessment of informal reasoning: quality and patterns. Measurements of informal reasoning quality typically assess the coherence and consistency of arguments, along with the ability of the individual to formulate arguments from differing perspectives (Kuhn, 1991).

Informal reasoning patterns are the “patterns of data interpretation and information evaluation” demonstrated by individuals when reaching conclusions regarding selected SSI (Sadler & Zeidler, 2005, p. 114). The principles subsuming these patterns have been broadly described as rationalistic, emotive, and intuitive. Using the works of Yang and Anderson (2003) along with Patronis, Potari, and Spiliotopoulou (1999), Wu and Tsai (2007) have presented a third representation of informal reasoning: reasoning mode. Informal reasoning modes describe the perspective or orientation demonstrated by the decision maker. These reasoning modes generally separate scientific and social perspectives.

Patterns of reasoning. Sadler and Zeidler (2005) examined patterns of informal reasoning surrounding genetic engineering. Interviews were conducted with 30 college students, 15 of these had an extensive background in natural science and 15 did not. From these interviews three broad patterns of informal reasoning used in reaching conclusions were identified: 1) rationalistic, 2) emotive, and 3) intuitive. In emotive informal reasoning the individual reaches a conclusion from a perspective that considers the well-being of others (Sadler & Zeidler, 2005). Intuitive reasoning relies on the immediate reaction an individual has to a scenario without consideration for the rational support for that position (Sadler & Zeidler, 2005). Rationalistic informal decision making relies on a reason-based consideration of the issue with a form of reasoning that is not immediately intuitive or based on the impact the resolution will have on the well-being of others (Sadler & Zeidler, 2005). Sadler and Zeidler (2005) found that individuals frequently used more than one of the aforementioned decision-making modes to form solutions.

As a part of the work previously described, Wu and Tsai (2007) simplified the work of Sadler and Zeidler (2005) to produce two broad categories of informal reasoning used to reach conclusions regarding SSI: intuitive and evidence-based. In this two category system arguments and underlying patterns of reasoning were described as those that used intuition to reach conclusions versus those who employed some reviewable evidence in the decision-making process. Wu and Tsai (2007) found that most students employed an evidence-based pattern of reasoning.

Reasoning modes. Patronis et al. (1999) examined student arguments dealing with a specific and authentic situation. Students were asked to plan a road construction project and prepare arguments to support their conclusions. Patronis et al. (1999) explored the arguments proposed by a class of 14-year old Greek students. Participants were asked to consider issues surrounding the planning of a road. This particular problem mimicked a genuine concern of individuals in the area where the research was conducted. In a series of written evaluations and class presentations the arguments of students were assessed. In qualitative assessments of the various data sources, Patronis et al. (1999) were able to categorize the arguments into four broad areas: economic development, ecological positions, humanistic or social perspectives, and a fourth category that included arguments that were directly applicable to the individual student. This was done in a quantitative manner based on the number of instances of each reasoning mode.

Yang and Anderson (2003) examined the information preferences and subsequent reasoning modes among Taiwanese high school students. This research included a questionnaire which was used to assess student preferences regarding the type of information used to make decisions about nuclear energy usage. These preferences were described as scientific-orientation and social-orientation. The academic success of the individual was determined to be a predictor of which information sources the individuals preferred. Students were then asked to make decisions regarding questions surrounding the impacts of nuclear energy use and the type of reasoning displayed was analyzed. It was found that participants most often used a reasoning method that corresponded with their information preferences, while subjects with a largely neutral orientation used both a social and scientific perspective on a regular basis (Yang & Anderson, 2003).

Employing the works of Yang and Anderson (2003) and Patronis et al. (1999), Wu and Tsai (2007) incorporated reasoning into their own method for assessing informal reasoning regarding socioscientific issues. Wu and Tsai (2007) developed a method for qualitative and quantitative evaluation of reasoning modes. In this framework, four broad categories were introduced to classify the reasoning modes displayed in arguments: social-oriented, economic-oriented, ecological-oriented, and science- or technology-oriented. A fifth category was used to encompass arguments using multiple reasoning modes. The resulting mixed-method assessment was used to explore the beliefs of 71 Grade 10 students in Taiwan regarding electrical power production. To apply quantitative techniques of data analysis students were asked to provide as many arguments as possible and occurrences of each reasoning mode were counted. Wu and Tsai (2007) found that most students employed multiple perspectives, but mention lower occurrences of science- or technology-oriented arguments.

Decision-making lenses. Halverson, Siegel, and Freyermuth (2009) offer an approach for considering the “lenses” used in the decision-making process regarding one SSI. Halverson et al. (2009) examined papers from 132 college students to determine how students make decisions regarding stem cell research. Eight different perspectives were ultimately identified: medical, ethics, rights, economic, religious, personal anecdote, political, and scientific. Participants most commonly used a medical perspective to make decisions, with ethics the second most common perspective. The remaining six categories were each used less than 25% of the time. In many instances (70%) multiple perspectives were used to make decisions. Among students employing a perspective that combined ethics and religion, most argued against the use of stem cell research. Interestingly, students were never found to combine a religious and scientific perspective. Exploring ideas such as the "lenses" used to make decisions seems important when attempting to explain how individuals formulate conclusions.

Reasoning quality. Argumentation is believed to reveal the reasoning skill possessed by an individual and is often introduced into science classrooms as a method for improving this reasoning ability (Acar, 2008). Prominent researchers into the topic have described reason as the core of argumentation (Kuhn, 1991), and argumentation has been used to assess reasoning quality. Studies with a focus outside of SSI have concluded that students display an insufficient ability to provide quality arguments (Kuhn, 1991; Perkins et al., 1991).

Modern methods to assess argumentation, including the previously mentioned research, typically begin with the work of Toulmin (1958), which created a framework for evaluating arguments. Arguments are said to begin with a claim that is supported by some type of data or less empirical grounds. Toulmin's model assesses the demonstrated logic, referred to as a warrant. It is this warrant which explains the data or grounds used to support a claim. The individual providing the argument may include additional information, which becomes relevant in a correlated situation. Often limits, referred to as qualifiers, will be placed on arguments. These qualifiers specify the situations in which the argument applies. Arguments will often include potential couner-arguments or address conditions where the argument is not true; these are referred to as rebuttals. The assessment of an argument provided by Toulmin begins a series of models for assessing argumentation and the underlying reasoning quality. An individual displaying proficient informal reasoning is able to produce a coherent argument that is not contrary to other positions and is able to consider multiple perspectives (Sadler & Zeidler, 2004). Toulmin's model remains relevant in modern studies; researchers (i.e., Erduran, Simon, & Osbourne, 2004) continue to develop and use direct modification of this important work.

Evidence exists which questions the direct relationship of argumentation and understanding. Kortland (1996), for example, explores argumentation patterns among middle school students tasked with reaching conclusions regarding environmentally relevant topics. Students were able to formulate arguments but were unlikely to effectively address opposing viewpoints (Kortland, 1996). Kortland (1996) observed relatively weak argumentation ability, likely the result of inexperience in forming arguments coupled with a lack of content knowledge. Following the previous conclusions, the researcher designed an intervention for improving argumentation. A reexamination of the same students following the intervention found improved understanding of scientific content and possibly better content knowledge. This was not, however, reflected in the student's ability to independently formulate a better argument. It has been suggested that argumentation ability will only be improved if methods of proper argument development are addressed.

Patronis et al. (1999) found more positive results concerning argumentation quality among a separate group of middle school students. Like Kortland (1996), Patronis et al. (1999) assessed argumentation patterns concerning local environmental issues, but the later study was more optimistic of the reasoning abilities of the students. Sadler (2004) questioned the methods employed by Patronis et al. (1999) to classify an argument as well-reasoned. Patronis et al. (1999) provide a possible explanation for their findings when they emphasize the local relevance of their study.

Jimenez-Aleixandre, Rodriquez, and Duschl (2000) examined discussions from a ninth grade class. The work addressed argumentation concerning genetic issues associated with poultry production. Jimenez-Aleixandre et al. (2000) reviewed transcripts from class discussions and found that 66% of student arguments made claims without supports and no arguments displayed the higher argumentation skills of qualifiers and rebuttals. A separate study from Zohar and Nemet (2002) found that, despite initial instances of poor argumentation ability, a modest intervention can have an important impact on displayed quality of reasoning. Sadler and Zeidler (2004) conclude that adept arguments do provide evidence of high quality reasoning, but they warn that poor argumentation may be the result of limited experience with formulating arguments. Means and Voss (1996) have demonstrated such instances of poor argumentation skill among those capable of high quality reasoning.

Sadler and Zeidler (2005) used the work of Toulmin (1958) and others to offer a mixed method approach to assess the quality of arguments produced within the context of SSI. Sadler and Zeidler (2004, 2005) developed a method of qualitatively assessing the reasoning empoyed by students. The criteria that emerged were intra-scenarion, inter-scenarion non-contradition, counterposition construction, and rebuttal construction. Intra-scenarion coherence requires participants to create a rationale that supports their stated opinions, inter-scenarion non-contradiction evaluates the lack of contradiction between aspects of a given rationale, counterposition construction assess a student's ability to form and explain counterposition, and rebuttal construction evaluates a student's ability to form counter-arguments. Sadler and Zeidler (2005) contend that a student who demonstrates each of the four requirements has shown advanced skill referred to as flowed reasoning.

The work of Sadler and Zeidler (2005) was used by Wu and Tsai (2007) in the development of a method for assessing reasoning quality. Wu and Tsai (2007) measured the number of arguments, rebuttals, and counter-arguments students were able to produce. Most students did provide some evidence to support their claims; many of these did not, however, display the most advanced aspect of reasoning. It was found that only 40% of students were able to provide any arguments counter to their own personal positions.

I found the methods presented in Sadler and Donnelly (2006) to provide the most useful method for quantitatively assessing the argumentation quality of an individual. In Sadler and Donnelly (2006) the assessment method used by Sadler and Zeidler (2005) was modified to a form more appropriate for quantitative evaluation. This method does not rely on measuring the number of responses, but focuses instead on the inclusion of certain aspects within the given responses. The method, presented in Sadler and Donnelly (2006), evaluates responses using three criteria: the ability of the individual to formulate and rationally support their own opinions, the ability of the individual to formulate responses from multiple-perspectives, and the ability to challenge the grounds of an opposing viewpoint. Respondents were given points based on their ability to complete each of these levels of argumentation quality.

Impact of Socioscientific Beliefs on Classroom Practices

Berkman et al. (2008) found the two most likely reasons for variations in the coverage of evolution within schools were the teachers' personal beliefs about the validity of evolution and the number of hours the teacher had accumulated in college science. Berkman et al. (2008) found that 16% of high school biology teachers surveyed believed the earth was less than 10,000 years old and that humans had been placed on the Earth in close to their current form. In addition, 9% stated they had no opinion or did not provide an answer regarding the origins of the Earth and the human form. A separate study found 48% of the general public believes this young Earth and young human form idea with an additional 9% having no opinion or providing no opinion (Plutzer & Berkman, 2008). Despite the debate among educators and the general public, for most scientists the debate surrounding evolution is a largely settled matter (Berkman et al., 2008). Thus, the lack of a universal consensus is not likely the result of a dearth of scientific evidence, but rather what Levinson (2006a) would describe as a fundamentally different theoretical framework concerning the role of evidence.

Some of the variation in the classroom practices of teachers is likely due to differences in content knowledge. It has also been shown that variations in understanding of the nature of science relates to different practices in the high school classroom (Lederman, 1999). Factors beyond content and beliefs of the teacher do impact classroom practices. The opinions of the local community, for example, correlate with teaching practices regarding evolution, even if the subject is included in the state standards (Berkman & Plutzer, 2010). The impact of the general public is especially noticeable when the subject matter is not covered on a state-level test. The number of college biology courses taken by the high school instructor is a likely indicator of the willingness of the individual to teach evolution (Berkman et al., 2008). This is true even in those instances where the outside community does not believe evolution should be a required part of the curriculum (Berkman & Plutzer, 2010). Teachers do not directly decide what is included in the standards, but they are the final deciders of which standards are actually taught (Spillane & Callahan, 2000). Most of the information relating the opinions of teachers to classroom practices surrounds evolution, but it is likely that teacher opinion also impacts instruction concerning embryonic stem cell research and anthropogenic climate change. It seems clear that simply placing a topic in the state curriculum is not tantamount to ensuring that each child receives adequate instruction in that area.

Multiple surveys of college students have revealed fairly consistent results regarding the coverage of evolution within the high school science classroom. One study of students enrolled in an introductory science course at the University of Minnesota found 62% had been in a high school biology course that included only evolution (Moore, Brooks, & Cotner, 2011). Of the remaining respondents 3% had been in a high school course that discussed only creationism, 22% in courses that included both, and 13% that discussed neither. When different students at the same university and enrolled in a similar course were divided into majors and non-majors, similar results were observed (Moore & Cotner, 2009a; Moore & Cotner, 2009b). The prior studies indicate that most students are being exposed to aspects of evolution. The 13% of students who indicated a lack inclusion is somewhat concerning. In light of argumentation, the mere inclusion of creationism does not indicate a conflict between science instruction and accepted scientific principles. The 22% previously cited is, however, consistent with other studies which found that some 25% of teachers find creationism to be supportable using scientific principles (Moore & Kraemer, 2005).

The understanding of evolutionary principles among educators has been questioned, but student exposure to evolutionary ideas does have a positive impact (Moore et al., 2011). The nature of high school instruction has been shown to correlate with student beliefs. Those participants whose high school instruction included only evolution were more likely to accept evolution-based claims compared with those who experienced only creation instruction; the counter of this argument was also found to be true (Moore & Cotner, 2009b). Poor understanding of the topic, religious beliefs, external pressures, and ignorance of the law have all been cited as reasons teachers might include creationism and limit evolution-based instruction (Moore & Cotner, 2009b).

In 2011 the National Earth Science Teachers Association (NESTA) conducted an informal survey to assess the beliefs of K-12 educators regarding climate change. An overwhelming majority of respondents (89%) believed that climate change was happening, while only 6% did not believe global warming was real (Johnson & Holtzer, 2011). A study of Americans that was not limited to teachers found a less impressive 54% of teens and 63% of adults believe global warming is happening (Leiserowitz, et al., 2011). Only 50% of adults were willing to say that human activities are responsible for most of the global warming that is occurring (Leiserowitz, Smith, & Marlon, 2011). In contrast, the NESTA study found that only 13% of the responding educators believed climate change to be the result of natural causes. The previous studies provide an indication that science teachers are more willing than the general public to accept the science of climate change. The indicated belief in climate change among educators may not, however, be transferred to students. Only 27% of teens say they learned a lot about climate change in school with 70% saying they would like to have learned more (Leiserowitz et al., 2011).

Some of the lack of coverage of climate change may be the result of outside influences. The NESTA survey found only 5% of teachers are required to teach both sides of the climate change issue, but 36% have been influenced to teach both sides of the issue (Johnson & Holtzer, 2011). Almost half (47%) taught both sides of the issues because they believed both sides to have some scientific validity. Regardless of the reasons, the Yale Project on Climate Change Communication has found an alarming lack of understanding among school-aged individuals (Leiserowitz et al., 2011). Other studies have found that improvements in understanding are possible if proper instructional practices are followed (Nuangchalerm, 2010). The importance of discussing climate change in the classroom has been recognized by some organizations which have historically focused on the teaching of evolution. The National Center for Science Education is one of those organizations with a shifting emphasis toward the issue of climate change (Young, 2012).

Like climate change, misconceptions regarding stem cell research are common, but the level of misunderstanding may be improved with the implementation of certain instructional practices (Concannon, Siegel, Halverson, & Freyermuth, 2010). These misconceptions and possible improvements may extend into individuals' understanding of public policies (Concannon et al., 2010). Concannon et al. (2010) emphasized the idea of misconception development and its impact on science literacy. All individuals are presented with inaccurate information, possibly from popular media sources. These sources may lead to the development of inaccurate personal beliefs (Posner, Strike, Hewson, & Gertzog, 1982). Positively influencing these conceptions is one of the primary goals of science literacy, but certain engrained ideas may be difficult to change. Altering a student's way of knowing is likely to require the presence of an authoritative figure, most often a teacher (Driver, Asoko, Leach, Mortimer, & Scott, 1994). The implementation of constructivist learning methods has produced positive changes in student conceptions (Dhindsa & Anderson, 2004). The possibility of success should be heartening to those trying to improve science literacy.

One study of teaching practices within the states of Ohio and Indiana found little difference in the coverage of evolution despite a wide difference in state standards (Bandoli, 2008). Overall, the coverage of the potentially controversial science topic seemed to be based on the views of educators; and evolution was rarely integrated throughout science courses (Bandoli, 2008). The inclusion or exclusion of science topic has been tied to three primary factors: beliefs of the teacher, pressure from outside forces, and treatment of the topic in state achievement tests (Bandoli, 2008). While Bandoli (2008) focused on evolution, the same aspects are likely influencing the treatment of stem cell research and climate change within classrooms. James Taylor of the Heartland institute believes "the core issue is not whether global warming is happening, or whether humans are involved, but whether it is a crisis" (Young, 2012). Such opinions are difficult for scientists to conclusively address and are almost certainly views that will impact the coverage of SSI in the classroom. The more important questions involve the impact such views will have on student beliefs.

The personal beliefs of teachers can have a great impact on the instruction demonstrated in the classroom (e.g., Berkman et al., 2008). It is likely that personal belief systems have the greatest impact on classroom instruction (Rutledge & Mitchell, 2002). Thus, exploring the personal beliefs of educators is likely more important than an examination of variations in required subject matter. Much of the prior research described has been used to explore personal beliefs regarding SSI, but these studies have rarely focused on educator views. Additionally, prior literature has assessed beliefs regarding certain SSI as instructional topics, but these works have not typically examined the reasons educators hold these positions. To explore the topics fully I feel it is important to understand the most controversial aspects of socioscientific issues, to assess teacher beliefs regarding the controversial aspects of the selected SSI, and to evaluate the reasoning quality and decision-making lenses used by these educators. A better understanding of these areas could be beneficial in addressing misconceptions of evolution, stem cell research, and global climate changes among teachers and students. Ultimately, understanding and addressing demonstrated conceptions regarding socioscientific issues could lead to more complete instructional practices and a more scientifically literate society.

CHAPTER III

METHODOLOGY

To assess the beliefs teachers hold regarding the most controversial aspects of evolution, stem cell research, and climate change I developed an instrument focused on these issues. Prior studies have had a related focus, but I found no assessment tool or methodology that could be used directly. To accomplish my goals the most controversial aspects of the topics needed to be identified. In addition, those background factors most likely impacting teachers' views needed to be identified. The results taken from the preliminary studies revealed that an examination of the informal reasoning underlying each issue was beyond the scope of this work. Therefore, a currently relevant piece of legislation was identified, which could be used to explore the informal reasoning among respondents. This legislation was intended to protect teachers who include alternative views of SSI within their science lessons. Ultimately, quantitative and qualitative techniques emerged as the methods for analyzing and describing the beliefs of educators regarding the SSI in question. To make the following discussion more meaningful I have included the completed tool (Appendix A). I have also included two figures to summarize the methods used in this study. Figure 1 illustrates the aspects that may be impacting teacher views, while Figure 2 outlines the methods used to evaluate responses.

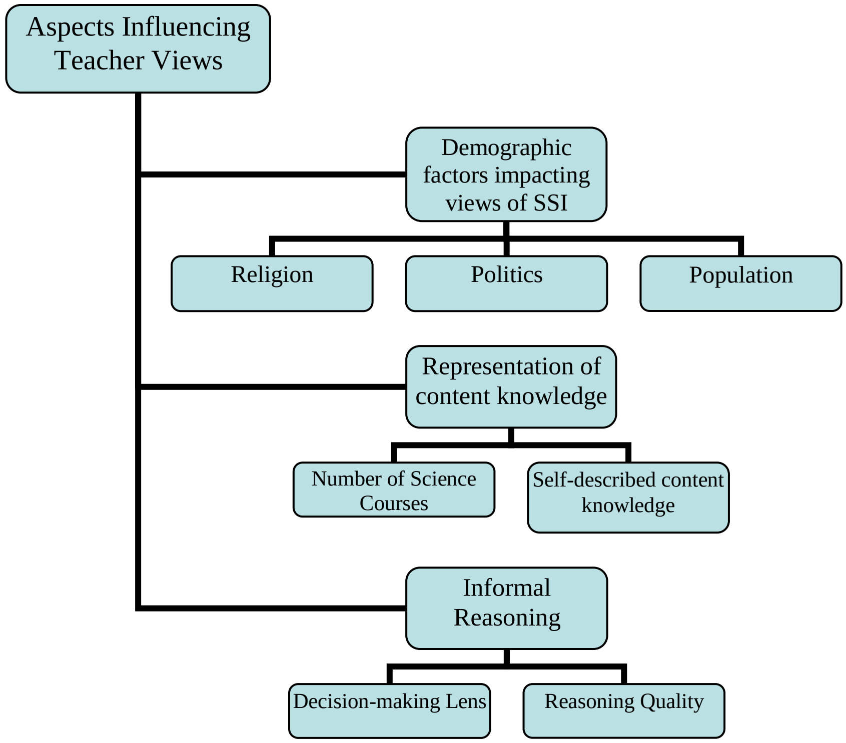

Figure 1. Factors impacting views of SSI. This figure illustrates those factors that are potentially impacting views of SSI and how these factors were measured in this study.

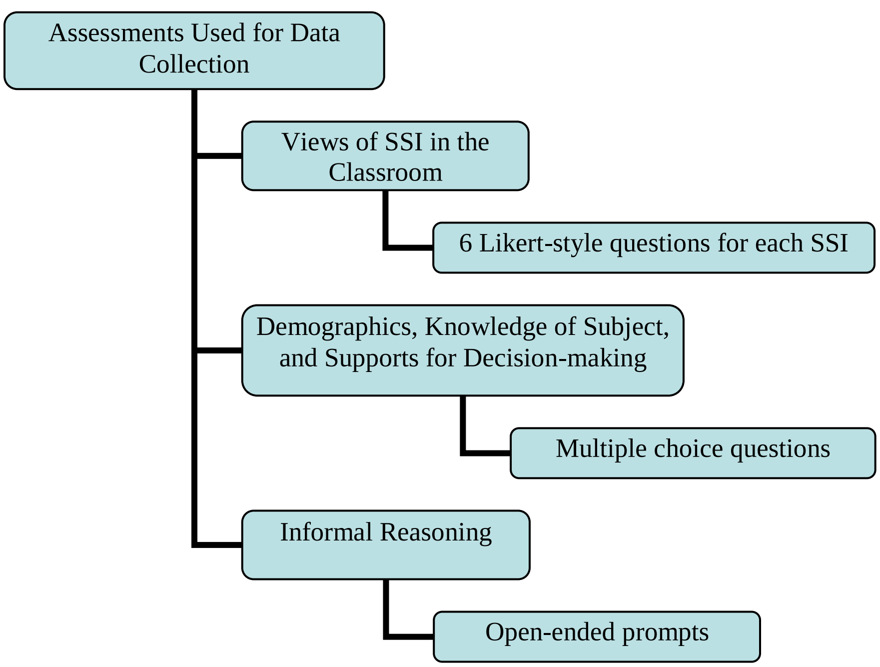

Figure 2. Methods used to evaluate the views of participants. These are the main categories assessed in this study and the methods used to assess them.

Participants and Data Collection

Participants in the study included a pilot group and a separate group for the main survey. For all participants the survey instrument was developed using the Survey Monkey website. The pilot group was taken from graduate students at the University of Southern Mississippi. This initial aspect of the study was used to test the reliability of the survey. Eighteen graduate students responded to the instrument via a link which was personally delivered to each individual. Of these 18 individuals, 15 completed each multiple-choice question. These results were tested using Cronbach's alpha statistic for reliability. In addition, members of the pilot group were free to comment on all aspects of the assessment.

For all parts of this study the assessment was delivered electronically. For the main part of the study, a link to the instrument was delivered to potential participants via email. Potential candidates were sent this link using publicly available educator email lists. The responding teachers came primarily from various areas in Mississippi, Tennessee, and Kentucky. Participants included elementary and secondary teachers and administrators. A total of 267 individuals responded to one or more parts of the survey. To be included in the final study, participants had to respond to enough of the background information to determine their current status. Included respondents were current teachers or administrators. In addition, respondents must have responded to a minimum of one complete set of 10 questions related to one of the three SSI. This left a total of 221 individuals who were included in the results. The gender and race of those participating in the study were not evenly distributed and were not representative of the national or regional population. Eighty percent of respondents were female and 92 %

were Caucasian. The remaining 8% consisted of 16 African Americans and 2 Hispanics. Of the 221 answering the multiple-choice queries, 134 responded to one or more open-ended portions of the assessment, and 113 fully completed all four prompts. Completion was not a requirement for inclusion in the open-ended analysis.

The final assessment included 16 background and demographic questions, 30 multiple-choice questions exploring beliefs related to SSI in the classroom, and four open-ended prompts. The 30 multiple choice questions included 10 questions addressing each of the three topics. Six of the 10 questions for each set specifically asked respondents to describe their views of aspects of the SSI using a Likert-style scale of assessment. The remaining four questions were intended to assess personal views of the science and the information sources used to develop these beliefs. For the open-ended portion of this assessment participants were given a prompt describing a controversial new law addressing SSI in the classroom. Respondents were asked to develop arguments for and against the described topic. Those responding to the survey were asked to address each issue, but this was not required for inclusion. Participants did need to respond to a minimum of 10 questions addressing one of the SSI included in the study.

Instrument Development

I was unable to find an assessment tool which fulfilled the specific needs of my study. Numerous instruments exist to measure opinions regarding evolution, stem cell research, and climate change, and I consulted many of these tools in the development of my survey and questionnaire. To assess views of SSI in the classroom a quantitative system was utilized to identify statistically significant differences between groups. Questions were developed to measure personal beliefs, beliefs regarding acceptability for the classroom, and sources used to reach conclusions. Prior literature and results from the preliminary study were used to identify the most controversial aspects of evolution, stem cell research, and global climate change.

Survey of Views of SSI in the Classroom

Educators in the science classroom are often unwilling to address SSI; this is true even in instances where the educator agrees with the underlying scientific principles supporting the topic (Berkman et al., 2008). Based on prior research and findings from my preliminary study, it was not assumed that the personal views of science could be used as an exclusive indicator of willingness to include controversial ideas into the curricula. Thus, questions focused specifically on beliefs regarding SSI in the classroom, and not on views of the underlying science. Responses from the pilot study found a number of instances where respondents believed topics were not appropriate due to the potential controversies which might ensue. Respondents were given the opportunity to identify both their personal views of the topics, and the reasons they believe the topics are or are not appropriate for the classroom.

Each participant began by responding to 16 questions focusing on personal aspects of their lives that were potentially impacting their view of SSI in the classroom. Participants were asked to provide information related to their religious views and practices, their political views and practices, and their educational background. The subject and grade level taught by each individual were additional pieces of information which were believed to be particularly relevant. This information was used to describe differences demonstrated in the remaining parts of the data.

Thirty questions, which focused directly on the selected SSI, were included in the survey. The survey was divided evenly with 10 questions designed to measure the willingness of the individual educator to include each of the three selected topics. Nine of these questions were developed using a Likert-style format with the one remaining question allowing participants to provide multiple responses as to who should be ultimately responsible for decisions allowing SSI in the classroom. Six of the nine questions for each topic specifically asked participants to describe their level of support for science topics. Three of these questions addressed scientific aspects of the controversy, and three of the questions took a view in support of the opposing perspective. Participants could agree or disagree with each statement without being contradictory. The three remaining questions in each set of 10 directly addressed personal views of the science supporting evolution, stem cell research, and global climate change.

Validation of Instrument

The survey and open-ended questionnaire were initially guided by previously published studies. Additionally, the clarification of aspects of the instrument has been a continuing process, beginning with the pilot study discussed previously. Expert review was the first method employed in revising the developing questionnaire. The questionnaire was then given to the preliminary group described above. Using SPSS 20, Cronbach's alpha analysis was run on the 18 items measuring teacher beliefs for the three SSI. This examination revealed an alpha of .739. Cronbach's alpha was also run isolating the analysis to those nine items, three from each SSI, which were in support of the scientific aspects of the topic. This found an alpha statistic of .773. A similar analysis was done using the nine items that took the opposite perspective, revealing a Cronbach's alpha of .855. All of these levels were within the acceptable range for reliability (Gliem & Gliem, 2003).

A Cronbach's alpha was used to test the reliability for the actual study. The alpha score for the entire model was .771. When the responses were isolated to questions measuring support for science the alpha score jumped to .844. For the nine questions measuring alternative perspective Cronbach's alpha found a score of .831. Results for all Cronbach's alphas can be seen in Table 8.

Table 8

Cronbach's Alpha Measures of Internal Consistency

Test Group	Questions Tested	Cronbach's Alpha Score
Preliminary	Overall Score – Includes responses to all 18 items	.739
	Pro-Science Perspective – 9 questions measuring perspective in support of science ideas	.773
	Alternative Perspective - 9 questions measuring perspective in support of alternative ideas	.855
Full Study	Overall Score – Includes responses to all 18 items	.771
	Pro-Science Perspective – 9 questions measuring perspective in support of science ideas	.844
	Alternative Perspective - 9 questions measuring perspective in support of alternative ideas	.831

Development of the Questionnaire

Results from the first two groups used in the development of the instrument found glaring inconsistencies. Responses to the open-ended portions of the assessment often did not address the topic or could not be assessed. To combat this problem a new perspective was taken. As the assessment tool was nearing completion the Tennessee state legislature was voting on a bill addressing SSI in the classroom. Tennessee House Bill 368/Senate Bill 893 is a somewhat vaguely worded piece of legislation intended to help “students develop critical thinking skills and [use] objective scientific facts” says one of the bill’s spokesmen, Representative Bill Dunn (Roberts, 2012). Those supporting the legislation believe it is simply an attempt to ensure topics, such as evolution, stem cell research, and global climate change, receive complete coverage including all sides of the controversy. Furthermore, the bill explicitly protects educators who include those sides of the issue which may oppose the predominant scientific perspective (Dunn, 2012). Opponents of the legislation believe it to be an attempt to mislead students into supporting the conclusion that some scientific issues are less certain, specifically, those ideas which are opposed on the basis of religious or social grounds (Cone, Webster, & Kaas, 2012).

To implement this current issue into in my study I wrote an essay in a style intended to resemble a short newspaper article. The results of this effort can be seen in Appendix B. The questionnaire was intended to be more relevant and interesting than merely asking participants to describe their views and opposing views. After reading the article, respondents were asked to provide an argument supporting their own opinion; in the literature this is referred to as position and rationale (Sadler & Donnelly, 2006). The prompts went on to ask individuals to take alternative perspectives and provide rebuttals for opposing positions. The provided responses were assessed qualitatively and somewhat quantitatively, with values being applied based on the ability of the individual to fulfill each aspect of the assessment. Possible scores ranged from 0 to 6. Those not responding to this aspect of the survey were noted, but were not included in the analysis.

Assessment of Informal Reasoning

Building on the work of others (Sadler & Donnely 2006; Sadler & Zeidler, 2005; Wu & Tsai, 2007), I developed a framework for analyzing the informal reasoning demonstrated by educators. The emerging questionnaire (Appendix B) was modified from an instrument developed by Wu and Tsai (2007). These questions are intended to measure multiple aspects of reasoning quality. Cumulatively, the assessment of reasoning quality includes the participant's ability to formulate and support arguments, formulate and support a counter-argument, and refute claims which could be made by others. Reasoning quality proceeds in a hierarchical fashion, with arguments supporting the position held by the individual being at the bottom and rebuttals of counter-arguments being the most advanced. Further analysis of these same questions can provide insight into the mode and patterns of reasoning used to reach conclusions. Halverson et al. (2009) use the expression "lenses for framing decisions" to describe to describe their investigation of how students reach decisions regarding stem cell research (p. 1249). A similar expression will be used for this study.

Decision-making lenses. Halverson et al. (2009) conducted a study into the decision-making lenses displayed among undergraduates. The study focused specifically on one SSI, stem cell research. After examining responses it was determined that eight lenses were found. The medical lens focused on possible medical applications. The ethics lens considered the moral acceptability of SCR. The rights of the embryos were considered in another lens. Economic issues were considered among those using one of the eight identified lenses. Those considering religious beliefs and those providing personal experiences were placed in two additional categories. The final two lenses included individuals who considered political ideology and those who considered the impact of basic science in their responses. Halverson et al. (2009) found that consideration of medical applications was the most frequently observed lens. In addition, it was determined that most individuals included multiple lenses, but the use of a scientific perspective was relatively rare. The use of multiple lenses did not mean each lens was used in the decision-making process equally. The limited use of the scientific lens was seen as a possible result of the lack of knowledge of the subject among decision makers.

Other research did not use the phrase decision-making lens, but was helpful in predicting the possible lenses that might be identified. In their study, Wu and Tsai (2007) used the number of social, economic, ecological, and science or technology arguments to quantitatively measure responses. Yang and Anderson (2003) had previously used scientific-oriented and social-oriented as the two main classifications of reasoning. Patronis et al. (1999) has classified modes of arguments as social, ecological, economic, and practical. Based on these previous works and expectations taken from the background study, I selected four likely categories before beginning the evaluation of responses: social, academic, individual, and practical.

Reasoning quality. Argumentation, since Toulmin (1958), has been analyzed from the perspective that the quality of reasoning can be revealed. Sadler and Zeidler (2004, 2005) used this in the development of a system that established a hierarchy of reasoning. This begins with an individual's ability to provide an argument and ends with the ability of the individual to consider multiple perspectives. Wu and Tsai (2007) developed a quantitative perspective for the analysis of reasoning quality. This was based on the number of arguments and perspectives the respondent was able to provide. I found Sadler and Donnelly (2006) to be the most useful in providing a rubric which could be used in assessing the reasoning quality demonstrated in this study. Table 9 provides an illustration of this rubric. It is similar to the one produced by Sadler and Donnelly (2006) with some important modifications.

Table 9

Criteria for Assessing Reasoning Quality Using Quantitative Means

Criterion	Score	Explanation
Position and Rationale	0	No response, uninformative response, or seemingly meaningless response.
	1	Respondent provides a meaningful response, but does not provide a rational argument in support of his/her own perspective
	2	Respondent does provide a coherent argument in support of his/her own perspective, but does not provide understandable or relevant support for the perspective
	3	Respondent does provide a coherent argument in support of his/her own perspective, as well as understandable and relevant support
Multiple Perspective Taking	0	No response, uninformative response, or seemingly meaningless response.
	1	Respondent provides a meaningful response, but does not provide a rational argument in support of a position that opposes his/her own perspective. Response may simply be a restatement of original position.
	2	Respondent provides a rational argument in support of a position that opposes his/her own perspective, but does not provide understandable or relevant support for the opposing perspective.
	3	Respondent provides a rational argument in support of a position that opposes his/her own perspective, as well as understandable and relevant support for the opposing perspective
Rebuttal	0	No response, uninformative response, or seemingly meaningless response.
	1	Respondent provides a meaningful response, but does not provide an argument which addresses the weaknesses in or challenges to an opposing perspective. Response may be simply be a restatement of original position.
	2	Respondent does reveal weakness in or challenges to the opposing perspective, but does not challenge the criteria supporting this opposing perspective
	3	Respondent does reveal weakness in or challenges to the opposing perspective, and challenges the criteria used to support this opposing perspective

Assessing Views of SSI in the Classroom

The beliefs of teachers regarding SSI are unlikely to be uniform. There is a clear division in those factors believed to impact socioscientific decisions. Content knowledge is one such factor; secondary science teachers have almost certainly had more exposure to scientific ideas than their counterparts in other elementary and secondary teaching professions. Isolating the study to secondary science educators may have been easier, but would have ignored the important role of those in lower grades or in other subject matter. Elementary teachers are often assigned with teaching all subjects; therefore, the beliefs of these educators can have an impact on the decisions students make regarding SSI beginning at an early age.

Despite the differences among educators, there are certain variables which are likely to impact opinions no matter the teaching status of the individual. Such factors include religious and political affiliations. Given the complex nature of SSI, it is unlikely that all aspects underlying beliefs were included in any analysis. It is my hope, however, that this work can begin to unravel the beliefs educators hold regarding SSI and the underlying reasoning used to support those views.

Assessing Views of Educators

This study included educators across a wide variety of subjects and grade levels. The dependent variables were taken from responses to the survey questions. Responses from these 18 questions, six for each SSI, were given a point value ranging from 1 to 5 with 5 being the most supportive and 1 point being the least. Three points were given to neutral answers. The total possible points for the survey section were 90. For each SSI 30 points indicated a person in strong agreement that the individual topics should be included in the classroom. Half of the questions measured level of support for the inclusion of topics, which would be strongly supported be the majority of the scientific community. The other half of the questions measure support for the inclusion of alternative perspectives. Thus, a score of 30 indicated an individual who wanted to see all aspects of the topic covered from a scientific and alternative perspective. The score for each SSI was recorded and referred to as the overall score. To provide a better understanding of the perspective taken by the educators, a perspective score was established by taking a cumulative score from those questions measuring support for the scientific perspective and subtracting cumulative scores from the questions measuring support for alternate ideas. A score of 12 indicated a support for only a scientific perspective, while a score of -12 indicated support for only an alternate perspective. A score of 0 indicated no preference for either side of the issues. Both the overall and perspective numbers were included in the analysis as dependent variables.

Personal Factors Impacting Views

Participants in this study were asked to respond to questions addressing their personal views of evolution, stem cell research, and global climate change. This included one question that addressed the sources of information the respondents found to be the most impactful on their decision making. As previously discussed, personal views of science are not necessarily correlated with individual views of what should or should not be included in the classroom. These personal views were, however, included in the survey instrument. Participants were asked to indicate their level of support for the science and evidence behind each of the three topics. In addition, respondents were asked to select from a Likert-style list the answer choice which best described their own level of understanding. Support for the science, support for the evidence, and personal level of understanding were scored using a 1 to 5 scale with the most positive views being given a score of 5. While personal views may not directly reveal the coverage of SSI in the classroom, it does seem an important predictor of the way the topics will be addressed. It may also be helpful in distinguishing those who avoid SSI because they disagree with the science and those who avoid the issues for practical reasons, such as the avoidance of arguments.

Based on prior literature three variables were identified as possibly correlated with SSI decisions. A number of religious institutions have been associated with views that oppose aspects of evolution (Leinisch, 2007; Ruse, 2005) and stem cell research (Holm, 2008). Religious affiliation and frequency of church attendance were both considered to be potentially relevant factors which could be related to views of SSI. The religious denominations from which participants could choose were taken from the list produced by the Pew Forum on Religion and Public Life (Pew Forum, 2008). Decisions concerning evolution, stem cell research, and climate change are politically relevant. Political affiliations have been especially visible for the topic of climate change (Merrill & Schizer, 2010). The current and previous U.S. Presidents illustrate the different views of stem cell research. These individual differences seem to be a reflection of the divergent views of the subject held by political parties. Considering the possibility that such views might impact coverage of SSI in the classroom, respondents were asked to select the political party and ideology which best represented their personal views.

Representation of Content Knowledge

The existence of a relationship between content knowledge and decision making has been identified, but this association has yet to be directly defined (Means & Voss, 1996; Sadler & Zeidler, 2005). Sadler and Donnelly (2006) have described a "Threshold Model of Knowledge of Transfer" to account for variations in conceptual understanding. Using a similar idea, the number of science courses taken in college has been employed to account for the variations in content knowledge used to support beliefs regarding SSI (Berkman et al., 2008). I did not include an instrument to directly measure content knowledge. I feared the time necessary for participants to complete such an instrument would limit the full expression of views regarding the selected SSI. To account for possible differences in content knowledge, respondents were asked to list the number and type of college science courses they have taken. Participating teachers were also asked to provide the classes they teach, including the grade level. It is likely that those teaching secondary science have taken more college science courses. The courses taught could also have an impact on content knowledge that has developed since the completion of college.

Statistical Analysis of SSI Beliefs

SPSS 20 (IBM Corp., 2011) was used to run all of the statistical tests for this study. As previously mentioned a Cronbach's alpha was used to test the reliability of the pilot study. One of the dependent variables for the quantitative portion was taken from participant scores when Likert-scores were added together. This was referred to as the overall score. The same procedure was done for each of the three SSI. The remaining dependent variables were taken when scores in support of including the scientific perspectives and scores in support of an alternative perspective were added separately, and the difference between these two groups was taken. This was referred to as perspective with positive scores, indicating a scientific leaning, and negative scores, indicating a viewpoint in favor of an alternative perspective. Multiple t-tests, analyses of variances (ANOVA), and chi-square tests were used to identify possible relationships between the independent variables and views of SSI. Categorical variables were developed following examinations of frequency data. The resulting distributions were separated in a manner intended to produce the most evenly sized categories. Table 10 provides a summary of the quantitative variables used in the model.

Table 10

Variables Used in Quantitative Analysis

Type of Variable	Variable Measured	Levels
Dependent	Overall level of acceptance of SSI	Possible values ranging from 18 to 90. 18 indicating lowest acceptance of SSI and 90 indicating the highest.
	Overall level of acceptance for each SSI	Possible values ranging from 6 to 30. 6 indicating lowest acceptance of SSI and 30 indicating the highest.
	Perspective overall	Possible values ranging from -36 to +36. -36 indicating highest support for alternative perspectives and +36 indicating highest support for scientific perspectives.
	Perspective for each SSI	Possible values ranging from -12 to +12. -12 indicating highest support for alternative perspectives and +12 indicating highest support for scientific perspectives.
	Pro-science and pro-alternative score for each SSI	Possible values ranging from 3 to 15. 3 indicating the lowest possible support for that perspective and 15 indicating the highest possible support.

Table 10 (continued).

Type of Variable	Variable Measured	Levels
Independent	Population	Rural and Urban
	Religion	Evangelical and Other
	Church Attendance	Weekly and Less than Weekly
	Political Party	Democrat, Republican, and Independent
	Number of Science Courses	Low: 0-2 classes; Medium: 2-11 courses; High: 12 or more
	Self-described knowledge	Above average and average or below
	Teaching Group	Elementary, non-science; Elementary, science; Middle, non-science; Middle, science; High, non-science; High, science; Administration

Informal Reasoning Underlying Beliefs about SSI in the Classroom

All individuals use informal reasoning to reach conclusions concerning SSI. In this study I examined aspects of informal reasoning among elementary and secondary educators in a quantitative and qualitative fashion. The evaluation instrument that emerged was guided by prior research (Sadler & Donnelly, 2006; Wu & Tsai, 2007). Open-ended prompts were used to evaluate aspects of reasoning among participating educators. Reasoning quality and lenses used to make decisions were the primary aspects considered in this evaluation. As previously described, a summary of a currently relevant piece of legislation focused on SSI in the classroom was used as a platform for evaluating multiple aspects of reasoning. Supporters of this legislation emphasize it was intended to ensure the coverage of science topics is “balanced” . This tactic is not original, and it is seen by opponents as a hidden attempt to interject religious views into the science classroom. Participants were given prompts to guide their open-ended evaluation of this type of legislation. Views of the legislation are important, but I was primarily concerned with the reasoning underlying these views.

Four prompts were used to evaluate teacher views concerning laws like the one described. One hundred and twenty-two of the participating educators completed all four prompts and were included in the evaluation. The initial prompt allowed participants to directly address their support for such laws. Support could be measured in a strictly quantitative manner and was not ambiguous for any of the included responses. These numbers were measured and frequency analyses were included with responses divided among the seven educators groups included in the study: elementary, non-science; elementary, science; middle school, non-science; middle school, science; high school, non-science; high school, science; and administrative.

For evaluation, responses were arranged in an electronic spreadsheet and line-by-line coding was used to compare all replies. The rubric shown in Table 9 was used as a guide in the analysis of reasoning quality. A rich description was ultimately developed to explain the evaluation methods used in the identification of diverging reasoning qualities and in the application of the previous rubric. Reasoning quality numbers were assigned, and the overall reasoning quality demonstrated among the educators was considered. This analysis included descriptive statistics and rich descriptions identifying any notable variations. A group of non-educators was not included in the study; therefore, the meaning of the reasoning quality results was largely speculative. The statistical analyses which were conducted included two ANOVA tests evaluating the relationship between number of science courses taken and teaching assignment. I hoped to identify a relationship between these variables and variations in reasoning quality. In addition, a t-test was employed to compare reasoning quality scores among those who support and those who oppose the discussed SSI legislation. Linear regression analysis was used to evaluate the existence of any possible relationship between reasoning quality score and overall view of SSI in the curriculum. A separate linear regression was used to evaluate the relationship between reasoning quality and preferred perspective for socioscientific topics.

Much of the analysis of informal reasoning focused on those lenses used by educators during the decision-making process. In this analysis the previously mentioned spreadsheet of responses was analyzed using line-by-line coding. Social, academic, individual, and practical were seen as the most likely lenses used in support of opinions. Inductive reasoning was used to identify any additional lenses that had not been previously considered. A rich description was developed for the illustration of each identified lens. The most enlightened or intriguing responses were isolated and included in these descriptions. Frequencies for each lens were compiled and reported. The larger lenses were further divided considering the nature of the specific response. T-tests were used to compare lenses with respondents' views of SSI as an appropriate topic for the science classroom. The dependent variable in these analyses included reasoning quality, overall view of SSI in the classroom, and preferred perspective.

Taken in its totality the assessment tool used in this work is designed to quantitatively and qualitatively assess the views educators hold concerning SSI in the classroom. Respondents' views of the science itself were considered, but were not the focus of this research. I was primarily interested in educators' views of SSI in the classroom and the reasoning supporting those conclusions. The assessment includes a portion focused on those backgrounds factors which are likely associated with certain views of SSI. These demographic and background factors are not specific to educators, but likely impact all individuals, including educators. The final portion of this instrument is intended to measure reasoning quality and identify the lenses used by individuals in reaching conclusions concerning SSI in the classroom. An analysis of the reasoning behind each topic was determined to be beyond the scope of this work, and a representative topic was included for the identification of the different ways educators approach SSI in the classroom. This assessment tool represents an attempt to holistically asses the views of educators and to provide an additional possibility for better addressing SSI in schools.

CHAPTER IV

RESULTS

The results included in the following pages are reported in a purposeful order. First, the overall views and the views of each topic are described. This includes views for the inclusion of SSI when all aspects are covered and the perspective preferred by each respondent. The perspective score is an indication of level of support for science-supported ideas in the classroom. Next, these same measures are included and separated using demographic factors as the grouping variable. This includes number of science classes and self-described understanding of the topics, the two factors used in this work to assess content knowledge. This is followed by an analysis of views of SSI in the classroom among individuals within different teaching groups. These groups are intended to reflect the current teaching status of the respondent. This is followed by a report of the views respondents hold regarding the science underlying the included SSI. Like the previous results, this has been separated by teaching position.

Following the previously described analyses, I include a summary of those factors most impacting educator’s beliefs. These factors include the variables teachers believe are most impacting their decisions and the individuals these teachers want to ultimately make the decisions regarding SSI in the classroom. Finally, the open-ended analysis is described. This contains an overall view of a specific piece of SSI legislation, the displayed reasoning quality, and the lenses used to make decisions concerning each topic. All of the previously described material can be found in the results section which follows. A more complete discussion of these results can be found in the last section of this work.

Overall View of SSI in Curriculum

A majority (73.3%) of educators in this study were in support of including SSI in the curriculum. A total of 182 individuals completed each of the 18 questions covering evolution, stem cell research, and global climate change. The mean score, as seen in Table 11, for the inclusion of SSI was 63.5. The lowest possible score, indicating a person who felt all aspects should have been excluded, was 18; the highest possible score was 90. Responding neutral to each question would have resulted in a score of 54; the collected responses were clearly above this number. As can be seen in Table 12, 162 or 73.3% of total participants agreed that SSI should be included in the science curricula. If this number is isolated to those answering all 18 questions the percentage in agreement with the inclusion of SSI jumps to 89%.

Table 11

Overall Support for the Inclusion of SSI

N	182
Minimum	34.0
Maximum	90.0
Mean	63.5
Standard Deviation	8.77

Table 12

Group Placement for the Overall Support for the Inclusion of SSI

	Frequency	Percent
Disagree	18	8.1%
Neutral	2	1.1%
Agree	162	73.3%
Missing	39	17.6%

For each SSI three of the questions were asked from a perspective that supported the inclusion of scientific ideas, and the remaining three prompts took an alternative perspective. An individual who answered "strongly agree" to each of the questions from a scientific perspective would receive a score of 45. A respondent with the completely opposite perspective would receive a score of -45. To construct an indicator of perspective the difference between the two numbers was computed for each respondent. A summary of the results for this calculation can be seen in Table 13. As seen in Table 14, a total of 51.6% of respondents took a more postive view of the science perspective, compared with the 23.1% who took a positive view of alternative perspectives. When the 39 respondents who did not respond completely are removed from the analysis, the previous numbers increase to 62.6% and 28.0% respectively.

Table 13

Preferred Perspective for the Inclusion of SSI

N	182
Minimum	-17.0
Maximum	35.0
Mean	3.43
Standard Deviation	9.29

Table 14

Preferred Perspective for SSI in the Classroom by Group

	Frequency	Percent
Alternatives	51	23.1%
Neutral	17	7.7%
Science Perspective	114	51.6%
Missing	39	17.6%

In an attempt to identify a relationship between overall score and perspective score a linear regression was performed. Overall score was used as the independent variable, with perspective score being the dependent variable. Overall view of SSI in the curriculum did not significantly predict perspective score, R^2 = .010, F (1, 180)= 1.893, p= .171. In addition, overall view of SSI did not explain a significant proportion of preferred perspective, β = -.108, t(180) = -1.376, p= .171.

Support for the Inclusion of Evolution

To better describe the views of educators each of the SSI was isolated. Table 15 shows that an overall mean score of 20.5 was calculated among 203 respondents. This indicates a somewhat tepid support for the overall inclusion of evolution and alternative ideas in the science classroom. A score of 18 would have been a neutral average. Table 16 supports this conclusion, indicating that 61.6% agreed with the inclusion of this particular SSI. An examination of each question, as seen in Table 17, shows highest support for the generic inclusion of evolution, while the least support exists for the inclusion of materials that support alternative theories. The third highest level of support was seen for the inclusion of a divine creator in evolution discussions, while the inclusion of human evolution received the fourth highest level of support.

Table 15

Overall Support for the Inclusion of Evolution

N	203
Minimum	9.00
Maximum	30.0
Mean	20.5
Standard Deviation	4.44

Table 16

Group Placement for Overall Support for the Inclusion of Evolution

	Frequency	Percent
Disagree	35	17.2%
Neutral	43	21.2%
Agree	125	61.6%

Table 17

Level of Agreement for Included Different Aspects of Evolution in the Science Curricula

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean
Include evolution	22	14	31	89	55	3.67
Include alternatives	33	25	35	78	40	3.32
Supports for evolution	23	27	37	76	48	3.47
Supports for alternatives	34	25	41	69	43	3.29
Human Evolution	27	28	37	81	35	3.33
Discuss Creator	27	25	48	67	43	3.35

Tables 18 and 19 reveal an inconclusive perspective among participants. The mean score indicates an overall result only slightly positive (.48). This does not mean that participants were neutral in their perspective. Only 28.6% of individuals had a neutral result with 76 of 203 taking a pro-evolution perspective and 69 in support of alternative views. Of the 76 participants who supported evolutionary ideas 10 had a score of +1 and 12 had a score of +2, while 14 had a score of +12. Of those 69 who indicated a support for alternative ideas, 15 had a score of -1.

Table 18

Perspective Score Describing Support for Evolution Versus Alternative Ideas

N	203
Minimum	-12.0
Maximum	12.0
Mean	.483
Standard Deviation	5.62

Table 19

Group Placement for Perspective of Evolution Versus Alternative Topics

	Frequency	Percent
Alternatives	69	34.0%
Neutral	58	28.6%
Evolution	76	37.4%

Support for the Inclusion of Stem Cell Research

Table 20 shows an overall support for the inclusion of stem cell research (SCR) was demonstrated by a mean score of 21.0. As seen in Table 21, discussion of medical benefits received the highest scores, while discussing the rights of embryos versus the benefit to patients received the lowest level of support. Table 22 shows a high percentage of individuals (69.7%) who fall into a category that generally supports the inclusion of SCR into the science classroom.

Table 20

Overall Support for the Inclusion of Stem Cell Research

N	205
Minimum	6.00
Maximum	30.0
Mean	21.0
Standard Deviation	4.36

Table 21

Level of Agreement for Including Different Aspects of Stem Cell Research in the Science Curricula

Selected topic:	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean
Include ethical discussion	8	16	44	106	34	3.68
Rights of embryos	16	20	44	92	36	3.54
Medical benefits	9	11	47	103	38	3.72
Embryos vs. patients	20	24	68	78	19	3.25
Can be ethical	10	22	64	86	27	3.47
Cannot be ethical	18	25	55	85	25	3.36

Table 22

Group Placement for Overall Support for the Inclusion of SCR

	Frequency	Percent
Disagree	32	15.6%
Neutral	30	14.6%
Agree	143	69.7%

Table 23 shows the perspective score for stem cell research in the science classroom. Like the previous study a score of 0 represents no discernible preference. As shown in Table 24, nearly half (49.8%) had this perspective. For this topic a positive score would indicate a preference for the benefits of stem cell research, while a negative score would indicate concern for the rights of embryos. The mean for this topic supports the idea that neither side was clearly preferred. The actual scores of those who showed some preference for stem cell research included 48 who had scores of +1 or +2, 24 for each. Also supporting this near neutral perspective, 14 of those with the pro-embryo position had a score of -1.

Table 23

Perspective Score Describing Support for Stem Cell Research Versus the Rights of Embryos

N	207
Minimum	-6.00
Maximum	8.00
Mean	.556
Standard Deviation	1.95

Table 24

Group Placement for Perspective Score Describing Support for Stem Cell Research Versus the Rights of Embryos

	Frequency	Percent
Pro-embryo	31	15.0
Neutral	103	49.8
Pro-stem cell research	73	35.3

Support for the Inclusion of Climate Change

Of the three SSI, educators were the most willing to include climate change in the science curricula. Table 25 shows the average mean for this topic was 21.9. Levels of support for the idea that climate change is occurring and the idea that pollution is contributing to climate change were greater than 4. This corresponds with an "agree" among the test population as a whole. The only mean score below 3 was seen when educators were asked to provide their level of support for the idea that climate change cannot be stopped. A full description for each question can be seen in Table 26. Only six respondents, or 3% of respondents, disagreed with the idea that climate change should be included in the science curricula. An analysis of group placements for educators can be seen in Table 27.

Table 25

Overall Support for the Inclusion of Climate Change

N	199
Minimum	113
Maximum	30.0
Mean	21.9
Standard Deviation	2.92

Table 26

Level of Agreement for Included Different Aspects of Climate Change in the Science Curricula

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean
Climate change is occurring	4	4	26	120	51	4.02
Climate change is natural	9	23	35	117	21	3.58
Climate is impacted by pollution	0	3	17	121	65	4.20
Combating climate change will hurt the economy	8	27	68	86	17	3.38
Climate change can be reversed	2	4	47	117	34	3.87
Climate change can't be stopped	20	57	59	58	10	2.91

Table 27

Group Placement for Overall Support of the Inclusion of Climate Change

	Frequency	Percent
Disagree	6	3.0
Neutral	15	7.5
Agree	178	89.4

Participants' perspectives on climate change were the most supportive of scientific principles when compared with the other two SSI included in the study. Table 28 supports the idea that most respondents took a pro-science perspective. Approximately two-thirds of respondents (66.8%) took a pro-science stance for the topic. The frequency and percentage of those with an alternative perspective and those with a neutral view can be seen in Table 29. Of the 133 who indicated a support for climate change ideas, 35 had a score of +1 and 25 had a score of +2.

Table 28

Results for the Inclusion of Pro-Climate Change Versus Anti-Climate Change Topics

N	199
Minimum	-6
Maximum	12
Mean	2.20
Standard Deviation	2.96

Table 29

Group Placement for Pro-Climate Change Versus Anti-Climate Change Topics

	Frequency	Percent
Anti-climate change	13	6.5
Neutral	53	26.6
Pro-climate change	133	66.8

For all of the three SSI the inclusion of the topic received overall supportive reviews. The highest level of support was seen for the inclusion of climate change, while the lowest level was seen for evolution. This was also reflected in the perspectives demonstrated by respondents. The clearest support for a scientific perspective could be seen for climate change ideas. The most pronounced division can be seen among the large numbers of individuals in support of evolution topics and the large number of individuals in support of alternative perspective. Nowhere else in the analysis is a similar division present.

View of SSI Separated by Demographic Data

Several demographics believed to be related to views of SSI were included in this study. These factors were population, religion, weekly church attendance, political party, political ideology, number of science classes, and self-described content knowledge. In the following section these factors served as the independent or grouping variables with overall views of SSI or perspectives scores being the dependent variable.

View of SSI in the Classroom Separated by Population

Responses included the location of the individual by state, but the responses were not evenly distributed throughout the country. To account for differences based on location the population of the area was included. Four possible responses were included: rural, somewhat rural, somewhat urban, and urban. For the purposes of analysis two main groups, urban and rural, were used. The majority of respondents were from rural locations, but a sufficient contingent of urbanities was available. The actual numbers of each can be seen in Table 30.

Table 30

Population Groups for Participants

	Frequency	Percent
Rural	144	65.2
Urban	72	32.6
Missing	5	2.3

As shown in Table 31 support for the overall inclusion of SSI was positive for both rural and urban educators. This number was separated by approximately 1 point, a difference which was not significant (p= .49). A different result was produced when the perspective score was analyzed. Both rural and urban groups had a view in support of science, but those from urban locals had a view that was 5.7 points higher than their rural counterparts. This difference was significant (*p*< .01).

Table 31

Views of SSI in the Classroom Separated by Population

		Rural	Urban
Overall Score	N	113	64
	Mean	63.9	63.0
	Standard Deviation	8.53	9.42
	Significance $t(175)= .686$, $p=.493$, *ns*.		
Perspective Score	N	113	64
	Mean	1.00	6.72
	Standard Deviation	7.72	9.79
	Significance $t(175)= -4.29$, $p< .001$.		

Participants from both rural and urban areas were supportive of the inclusion of evolution overall. As can be seen in Table 32, this support was slightly greater among the group from the less populated regions; the overall difference in scores was not significant (*p*=.66). Perspective scores did vary by a wider margin. In this instance, the rural population was more supportive of including discussions of the rights of embryos, producing a negative mean. The difference was large enough to be significant (*p*< .01).

Table 32

View of Evolution in the Classroom Separated by Population

		Rural	Urban
Overall Score	N	130	68
	Mean	20.6	20.3
	Standard Deviation	4.64	4.13
	Significance $t(196) = .447$, $p = .655$, *ns*.		
Perspective Score	N	130	68
	Mean	-1.02	2.94
	Standard Deviation	5.25	5.09
	Significance $t(196) = -5.10$, $p < .001$.		

Table 33 shows the results of an analysis similar to the previous described tests. In this instance stem cell scores were used as the dependent variable. The results show a greater willingness to accept all aspects of SSI into the curriculum for those teaching in rural areas. This difference was not, however, significant (*p*= .09). While less willing to accept SSI overall, urban educators were more open to those aspects of the topic which demonstrate the benefit of stem cell research. Those in rural areas had a near neutral score (x=.205), indicating little difference in support for the two areas. Among their fellow teachers from higher population areas, the stem cell research perspective was preferred, but this number (x= 1.01) was not overwhelmingly positive. Both measures are close to neutral, and the difference between the groups was not statistically significant.

Table 33

View of SCR in the Classroom Separated by Population

		Rural	Urban
Overall Score	N	130	70
	Mean	21.4	20.3
	Standard Deviation	4.41	4.27
	Significance $t(198) = 1.73$, $p = .085$, *ns.*		
Perspective Score	N	132	70
	Mean	.205	1.01
	Standard Deviation	1.72	2.06
	Significance $t(200) = -2.97$, $p = .003$.		

Test scores for climate change produced a somewhat different result compared to the previously mentioned SSI. These results can be seen in Table 34. When the urban members of the test group were compared with the rural group a more positive view of the inclusion of climate change topics was seen in the urban group. Both were willing to accept the inclusion of ideas related to climate, and the variation that did exist was not large enough to be significant. Like the evolution and SCR analysis, the urban population did take a perspective more in favor of scientific ideas, but unlike the previous two SSI, this difference was not statistically significant.

Table 34

View of Climate Change in the Classroom Separated by Population

		Rural	Urban
Overall Score	N	125	69
	Mean	21.7	22.4
	Standard Deviation	22.4	2.92
	Significance $t(192)= -1.55$, $p=.123$, *ns*.		
Perspective Score	N	125	69
	Mean	2.03	2.26
	Standard Deviation	2.71	3.27
	Significance $t(192)= -.523$, $p=.601$, *ns*.		

View of SSI in the Classroom Separated by Religious Affiliation

The largest number of participants described themselves as Evangelical Christians (see Table 35). As a result, the categories used for analysis in this study were Evangelical and other. Over two-thirds (67.9%) of respondents said they attended church more than once a week or weekly (see Table 36). This was compared with 14.9% who said they attended church rarely or never. I felt it was unlikely a difference would be seen between weekly attendees and more than weekly attendees. Therefore, church attendance was categorized by separating respondents into those who attended church at least weekly and an “other” group. The other group included a wide range of possibilities, from those who attended church a few times a month to those who never attended services.

Table 35

Religious Affiliation of Participants

	Frequency	Percent
Protestant, non-Evangelical	60	27.1
Evangelical	103	46.6
Catholic	24	10.9
Other	34	15.4

Table 36

Church Attendance among Participants

	Frequency	Percent
More than once a week	71	32.1
Once a week	81	36.7
Less than weekly	68	30.8

The relationship between religious affiliation and views of SSI in the science curriculum is shown in Table 37. The overall score was not significantly different (p= .79) with Evangelicals scoring only .35 points higher than all other religious groups. While more willing to include SSI as a whole, the Evangelical group had a view that was less supportive of the scientific perspective. The difference between Evangelicals and other religious groups was significant (p< .01).

Table 37

View of SSI in the Curriculum Separated by Religion

		Evangelical	Other
Overall Score	N	84	98
	Mean	63.7	63.3
	Standard Deviation	8.62	8.94
	Significance $t(180) = .267$, $p = .790$, *ns.*		
Perspective Score	N	84	98
	Mean	.179	8.50
	Standard Deviation	6.22	9.06
	Significance $t(180) = -4.62$, $p < .001$.		

The previous relationship between SSI and religion was seen independently for each topic. Tables 38, 39, and 40 illustrate this relationship for evolution, stem cell reach, and climate change, respectively. Each instance shows no significant difference in overall acceptance of each SSI, but a perspective score that is significantly different. In the view of those describing themselves as Evangelical a less positive view of scientific perspectives exists compared with their fellow teachers who are not Evangelical. In the case of evolution the perspective score is actually negative, indicating a preference for ideas alternative to evolution.

Table 38

View of Evolution in the Curriculum Separated by Religion

		Evangelical	Other
Overall Score	N	92	111
	Mean	20.2	20.7
	Standard Deviation	4.79	4.14
	Significance $t(201)= -.777$, $p= .438$, *ns.*		
Perspective Score	N	92	111
	Mean	-1.7935	2.3694
	Standard Deviation	5.02639	5.39685
	Significance $t(201)= -5.64$, $p< .001$.		

Table 39

View of SCR in the Curriculum Separated by Religion

		Evangelical	Other
Overall Score	N	95	110
	Mean	21.6	20.5
	Standard Deviation	3.96	4.63
	Significance $t(203)= 1.82$, $p= .070$, *ns.*		
Perspective Score	N	96	111
	Mean	.0104	1.03
	Standard Deviation	1.79	1.97
	Significance $t(203)= -3.86$, $p<.001$.		

Table 40

View of Climate Change in the Curriculum Separated by Religion

		Evangelical	Other
Overall Score	N	93	106
	Mean	21.6	22.2
	Standard Deviation	2.92	2.89
	Significance *t*(197)= -1.64, *p*=.104, *ns.*		
Perspective Score	N	93	106
	Mean	1.91	2.45
	Standard Deviation	2.97	2.95
	Significance *t*(197)= -1.28, *p*=.201, *ns.*		

Stem cell research has been an especially important issue among Catholics. Table 41 isolates views of SCR to those educators who describe themselves as Catholic. The number within this religious group is a relatively small percentage of the overall population. The indication from this analysis, however, is that Catholics are more willing to accept SCR into the curriculum, and the opinions of this group reflect an affinity for the scientific perspective. Thus, there is no reason to assume the Catholics within this test group support a perspective which promotes the protection of embryos to a noticeably higher degree.

Table 41

View of SCR in the Classroom among Catholics

		Catholic	Other
Overall Score	N	22	183
	Mean	22.3	20.8
	Standard Deviation	3.09	4.47
	Significance $t(203)= 1.48$, $p= .140$, *ns.*		
Perspective Score	N	22	185
	Mean	.955	.508
	Standard Deviation	1.73	1.98
	Significance $t(205)= 1.01$, $p= .312$, *ns.*		

View of SSI in the Classroom Separated by Church Attendance

Those who attend religious services weekly were only slightly less willing to accept aspects of SSI into the curriculum as compared to their counterparts who attended services less frequently. This difference of 0.51 was not significant (p=.72). Each group was willing to include the covered SSI, but the perspective scores ranged more significantly. Frequent church goers had a perspective score that was only .34 points above zero, while less frequent attendees had a score of 9.51. This difference was significant (p<.01). This information is provided in further detail in Table 42.

Table 42

View of SSI in the Curriculum Separated by Church Attendance

		Weekly	Other
Overall Score	N	122	59
	Mean	63.3	63.8
	Standard Deviation	8.54	9.33
	Significance *t*(179)= -.366, *p*= .715, *ns*.		
Perspective Score	N	122	59
	Mean	.336	9.51
	Standard Deviation	7.32	9.65
	Significance *t*(179)= -7.10, *p*<.001.		

Results similar to the overall data were seen when each topic was explored independently. Tables 43, 44, and 45 provide a more detailed analysis of these results. For evolution the difference in perspective score was particularly noticeable. Those who attended church most often had a mean score that was negative. This was the only instance where the demonstrated perspective revealed a preference for alternative ideas. In each case, the overall willingness to include each of the SSI was not significantly different, but less frequent attendees of religious services did take a perspective which was more supportive of scientific viewpoints.

Table 43

View of Evolution in the Curriculum Separated by Church Attendance

		Weekly	Other
Overall Score	N	138	64
	Mean	20.3	20.9
	Standard Deviation	4.73	3.70
	Significance $t(200) = -.911$, $p = .364$, *ns*.		
Perspective Score	N	138	64
	Mean	-1.40	4.42
	Standard Deviation	4.79	5.18
	Significance $t(200) = -7.83$, $p < .001$.		

Table 44

View of SCR in the Curriculum Separated by Church Attendance

		Weekly	Other
Overall Score	N	140	64
	Mean	20.9	21.1
	Standard Deviation	4.32	4.49
	Significance $t(202) = -.225$, $p = .823$, *ns*.		
Perspective Score	N	141	65
	Mean	.192	1.29
	Standard Deviation	1.78	2.09
	Significance $t(204) = -3.91$, $p < .001$.		

Table 45

View of Climate Change in the Curriculum Separated by Church Attendance

		Weekly	Other
Overall Score	N	136	62
	Mean	21.9	21.9
	Standard Deviation	2.73	3.31
	Significance *t*(196)= .029, *p*=.977, *ns*.		
Results Score	N	136	62
	Mean	1.68	3.23
	Standard Deviation	2.58	3.36
	Significance *t*(196)= -3.54, *p*< .001.		

View of SSI in the Classroom Separated by Political Party

The numbers of Republicans (81) and Democrats (84) who responded was somewhat even. The frequency of the two groups and the number of Independents can be seen in Table 46. Independents include those who described themselves as such and those who explicitly indicated they belonged to no political party. Close to half of the respondents (105) self-described as conservative. These numbers and percentage can be observed in greater detail in Table 47.

Table 46

Political Party of Participants

	Frequency	Percent
Democrat	84	38.0
Republican	81	36.7
Independent	50	22.6
Missing	6	2.7

Table 47

Participants Who Described Themselves as Conservative

	Frequency	Percent
Conservative	105	47.5
Other	111	50.2
Missing	5	2.3

The overall results for the inclusion of SSI in the science curriculum found support for the insertion of certain aspects of these topics without significant differences between any of the three political affiliations. The data in Table 48 illustrates the previous information and also reveals a significant difference when perspective is analyzed. Republican scores were lower than the same measure for their colleagues who were Democrats or Independents. An LSD post-hoc test confirmed that Republicans had significantly lower scores than the other two groups ($\alpha = .05$). Republicans had a score that actually demonstrated a preference for alternative ideas.

Table 48

View of SSI in the Curriculum Separated by Political Party

		Democrat	Republican	Independent
Overall Score	N	67	68	43
	Mean	63.4	63.2	63.9
	Standard Deviation	9.74	8.89	7.23
	Significance $F(2, 175) = .072$, $p = .931$, *ns*			
Perspective Score	N	67	68	43
	Mean	5.69	-1.18	6.42
	Standard Deviation	9.58	6.96	8.98
	Significance $F(2, 175) = 14.9$, $p < .001$.			

Analysis of each SSI separately confirmed the previously mentioned results. Tables 49, 50, and 51 show these data, revealing that in each instance Republican educators had a perspective score that was significantly lower. These results were confirmed with LSD post-hoc tests (α= .05). The analysis of perspective score for climate change violated Levene's test for equality of variances, but the difference remains significant when Welch's test is used (*p*< .01) (R. Mohn, personal communication, February 18, 2013). The data also confirms that general willingness to accept SSI into the science classroom was overall positive and did not vary significantly between groups.

Table 49

View of Evolution in the Curriculum Separated by Political Party

		Democrat	Republican	Independent
Overall Score	N	78	73	46
	Mean	20.8	20.0	20.8
	Standard Deviation	4.37	4.93	3.42
	Significance $F(2, 194)= .788$, $p= .456$, *ns.*			
Perspective Score	N	78	73	46
	Mean	1.36	-2.14	2.85
	Standard Deviation	5.78	4.15	5.65
	Significance $F(2,194)= 15.1$, $p< .001$.			

Table 50

View of SCR in the Curriculum Separated by Political Party

		Democrat	Republican	Independent
Overall Score	N	76	77	47
	Mean	20.5	21.4	21.0
	Standard Deviation	4.98	4.35	3.21
	Significance $F(2,197) = .818$, $p = .443$, *ns.*			
Perspective Score	N	78	77	47
	Mean	.987	-.156	.851
	Standard Deviation	1.89	1.72	1.93
	Significance $F(2,199) = 8.50$, $p < .001$.			

Table 51

View of Climate Change in the Curriculum Separated by Political Party

		Democrat	Republican	Independent
Overall Score	N	76	74	45
	Mean	22.2	21.5	22.1
	Standard Deviation	2.89	3.21	2.45
	Significance $F(2,192) = 1.20$, $p = .304$, *ns.*			
Perspective Score	N	76	74	45
	Mean	3.2632	.9595	2.4667
	Standard Deviation	3.10427	2.46865	2.82521
	Significance $F(2,192) = 12.830$, $p < .001$.*			

*Violates Levene (p=.01), Welch's: $p < .01$.

View of SSI in the Classroom Separated by Political Ideology

For the purposes of this study political ideology was divided into conservative and other. As seen in Table 52, the overall results for the comparison of scores show a score among conservatives that is less accepting of SSI into the curriculum. This difference is only 1.21 points and is not significant (*p*=.35). In both cases the score is above the 54 point threshold which would indicate a neutral response. A different result was found when perspective scores were analyzed. Conservatives had a perspective that was negative, indicating a preference for ideas that are alternative to a scientific viewpoint. Those who did not describe themselves as conservative had a score 8.67 points above neutral, indicating a preference for scientific perspectives. This difference was large enough to be significant (*p*<.01).

Table 52

View of SSI in the Curriculum Separated by Political Ideology

		Conservative	Other
Overall Score	N	89	89
	Mean	62.8	64.0
	Standard Deviation	8.63	8.67
	Significance $t(176)= -.936$, $p= .351$, *ns.*		
Perspective Score	N	89	89
	Mean	-1.38	8.21
	Standard Deviation	6.68	9.25
	Significance $t(176)= -7.93$, $p<.001$.		

For evolution and stem cell research the previous trend of non-significant overall scores and significant perspective scores held true. Each of the topics received an overall score above 18, which would have represented a neutral opinion. The precise scores and variances can be seen in Tables 53 and 54. In both instances conservatives had a negative perspective score, indicating preferences for non-scientific ideas. The difference in means for perspective was significant for both evolution (*p*< .01) and SCR (*p*<.01).

Table 53

View of Evolution in the Curriculum Separated by Political Ideology

		Conservative	Other
Overall Score	N	97	101
	Mean	20.0	21.0
	Standard Deviation	4.83	3.86
	Significance $t(196)= -1.50$, $p= .135$, *ns*.		
Perspective Score	N	97	101
	Mean	-2.52	3.35
	Standard Deviation	4.24	5.40
	Significance $t(196)= -8.47$, $p< .001$.		

Table 54

View of SCR in the Curriculum Separated by Political Ideology

		Conservative	Other
Overall Score	N	99	102
	Mean	21.0	21.0
	Standard Deviation	4.35	4.36
	Significance $t(199)= .094$, $p= .925$, *ns*.		
Perspective Score	N	99	104
	Mean	-.152	1.25
	Standard Deviation	1.62	2.04
	Significance $t(199)= -5.40$, $p< .001$.		

Climate change revealed a somewhat different result. As seen in Table 55, the overall scores for this SSI were once again positive, showing some level of support for coverage of the topic in the classroom. The mean differences in this instance was .84, which was significant (*p*= .04). For the first time the results score for perspective of climate change was not negative among conservatives, but the mean scores between conservative and other were significantly different.

Table 55

View of Climate Change in the Curriculum Separated by Political Ideology

		Conservative	Other
Overall Score	N	96	99
	Mean	21.5	22.3
	Standard Deviation	2.95	2.76
	Significance $t(193) = -2.04$, $p = .043$.		
Results Score	N	96	99
	Mean	1.17	3.20
	Standard Deviation	2.52	3.01
	Significance $t(193) = -5.12$, $p < .001$.		

View of SSI in the Classroom Separated by Number of College Science Classes

To find a measure of content knowledge without giving an assessment, participants were asked to list the number and kind of science courses they had taken while in college. Based on overall frequencies categories were established with 0-2 being low, 3-11 being mid-range, and 12 or more being high. Table 56 shows the frequencies and percentage for each of the three groups.

Table 56

Number of College Science Classes Taken by Participants

	Frequency	Percent
Low (0-2)	82	37.1
Mid (3-11)	59	26.7
High (12+)	80	36.2

Analysis of overall scores found a willingness among all groups to accept multiple aspects of SSI into the curriculum. The most positive results were found among those with the fewest science hours. As seen in Table 57 the variation in willingness to accept SSI into the curriculum was not statistically significant. The perspective score, however, did show a significant result ($p < .01$). All three groups had a perspective score that was positive. The values for low and medium were .23 and 2.00, respectively, indicating a greater willingness to include alternative perspectives. The score for those with more than 12 college science courses was 7.13, a difference which was significantly higher. LSD post-hoc analysis confirmed that the significant variation was between the high group and the other two categories ($\alpha = .05$).

Table 57

View of SSI in the Curriculum Separated by Number of Science Classes

		Low (0-2)	Medium (3-11)	High (12+)
Overall Score	N	61	49	72
	Mean	64.7	64.0	62.0
	Standard Deviation	8.75	9.96	7.80
	Significance $F(2,182)= 1.68$, $p= .190$, *ns*.			
Perspective Score	N	61	49	72
	Mean	.230	2.00	7.13
	Standard Deviation	7.03	8.62	10.2
	Significance $F(2, 182)= 11.0$, $p< .001$.			

Table 58 shows the overall scores and perspective scores for evolution with participants separated by number of science classes. Limited variation was seen in overall perspective. Each mean was over 18 indicating some level of support for the topic as a whole. An ANOVA confirmed that the variation in overall score was not significant (p=.34). For perspective score those with fewer science classes had a more negative view of evolution in the classroom. The score for this group was negative, indicating a preference for alternative ideas. The group in the middle had a completely neutral score. The 76 respondents who had taken 12 or more science classes produced the highest mean (2.47). An ANOVA confirmed this variation was significant (p<.01). An LSD post-hoc analysis confirmed that the significance was between those individuals with the highest number of science classes and the other two groups (α= .05).

Table 58

View of Evolution in the Curriculum Separated by Number of Science Classes

		Low (0-2)	Medium (3-11)	High (12+)
Overall Score	N	72	55	76
	Mean	20.6	21.1	19.9
	Standard Deviation	4.94	4.02	4.22
	Significance $F(2,200)= 1.09$, $p= .337$, *ns*.			
Perspective Score	N	72	55	76
	Mean	-1.25	.000	2.47
	Standard Deviation	4.63	5.49	5.99
	Significance $F(2, 200)= 9.07$, $p< .001$			

Tables 59 and 60 show similar results for the other two SSI included in this study. Like evolution, stem cell research and climate change showed no significance in overall score (p=.39 and p=.15). For stem cell research, like evolution, the group with the fewest science courses had a negative score, the group in the middle was only slightly positive, and the highest group was the most positive. An ANOVA confirmed the result was significant, but found the test violated Levene's test for homogeneity of variance (p=.003). Welch's more robust test confirmed the results were statistically significant (p< .01). Climate change perspective results were similar to those found for SCR. In this instance none of the perspectives were negative, but the group with the fewest science classes did have the least support for a pro-climate change perspective. An ANOVA found the differences in perspective to be significant (p=.01), but did find a violation of Levene's statistic. Welch's statistic did confirm a significant result (p= .03). LSD post-hoc analysis confirmed the significant difference was between the group with the most science courses and the other two groups.

Table 59

View of SCR in the Curriculum Separated by Number of Science Classes

		Low (0-2)	Medium (3-11)	High (12+)
Overall Score	N	72	55	78
	Mean	21.5	20.7	20.6
	Standard Deviation	4.26	4.98	3.96
	Significance $F(2,202)= .949$, $p= .389$, *ns.*			
Perspective Score	N	73	55	79
	Mean	-.0685	.418	1.23
	Standard Deviation	1.53	1.76	2.22
	Significance $F(2,204)= 9.21$, $p<.001$.*			

*Violates Levene's ($p= .003$); Welch's: $p< .001$.

Table 60

View of Climate Change in the Curriculum Separated by Number of Science Classes

		Low (0-2)	Medium (3-11)	High (12+)
Overall Score	N	70	53	76
	Mean	22.4	21.9	21.5
	Standard Deviation	2.98	2.72	2.96
	Significance $F(2, 196)= 1.91$, $p= .151$.			
Perspective Score	N	70	53	76
	Mean	1.67	1.79	2.97
	Standard Deviation	2.68	2.41	3.39
	Significance $F(2, 196)= 4.35$, $p=.014$.*			

*Violates Levene's ($p=.005$), Welch's: $p=.025$.

View of SSI in the Classroom Separated by Self-described Knowledge of Topic

Tables 61, 62, and 63 display the results for a comparison of views of SSI and perception of understanding of the subject. Participants in the study were asked to choose their level of understanding from a list of five options: excellent, above average, average, below average, and poor. Those selecting above average and excellent were compared with those describing their understanding as average and below. The overall score did not vary significantly for any of the three SSI. The perspective scores did not produce a consistent result. For evolution the mean score for those describing their understanding as average or below was negative. This number was not, however, significantly different (*p*=.10) when compared to the above average/excellent group. For stem cell research the above average group had a perspective that was less receptive of the pro-research view, a difference which was significant (*p*=.04). Climate change produced a different result, with the above average group being more supportive of science supported ideas; this difference was also significant (*p*< .01).

Table 61

View of Evolution among "Above Average" or "Excellent"

		Above Average	Average or Below
Overall score	N	102	100
	Mean	20.4	20.6
	Standard Deviation	4.25	4.66
	Significance	*t*(200)= -.316, *p*= .753, *ns*.	
Results score	N	102	100
	Mean	1.08	-.230
	Standard Deviation	7.06	3.40
	Significance	*t*(200)= 1.673, *p*=.096, *ns*.	

Table 62

View of SCR among "Above Average" or "Excellent"

		Above Average	Average or Below
Overall score	N	56	147
	Mean	21.4	20.8
	Standard Deviation	4.43	4.35
	Significance	*t*(201)= .899, *p*= .370, *ns.*	
Perspective score	N	56	149
	Mean	.383	1.02
	Standard Deviation	1.66	2.56
	Significance	*t*(203)= 2.081, *p*= .039.	

Table 63

View of Climate Change among "Above Average" or "Excellent"

		Above Average	Average or Below
Overall score	N	67	131
	Mean	21.9	21.9
	Standard Deviation	3.08	2.84
	Significance	*t*(196)= -.047, *p*= .963, *ns.*	
Results score	N	67	131
	Mean	3.54	1.53
	Standard Deviation	3.80	2.15
	Significance	*t*(196)= 4.74 , *p*< .001.	

View of SSI by Teaching Position

Much of the analysis done for this study required the separation of educators based on their teaching positions. The overall views of participants were compared using teaching position as the independent variable. The resulting scores for each group and the mean score can be seen in Table 64. An examination of these mean scores showed that elementary school science teachers were the least receptive of SSI in the curriculum, producing a mean score of 57.44. High school, non-science and middle school, non-science teachers were the only groups to produce a score over 66. An ANOVA test confirmed these results were significant. Post-hoc LSD and Scheffe tests revealed multiple instances of significance. Each instance of significance is shown in Table 65. Most of these significant differences included one of the three previously mentioned groups: elementary, science; middle school, non-science; or high school, non-science.

In addition to overall score, Table 64 also includes an analysis of perspective scores. A negative perspective, indicating a preference for ideas alternative to science, was found among elementary science and non-science teachers. Middle school and high school science teachers had a view that was the most supportive of a science perspective in the classroom, with each having a mean score over 8.50. The administration group score of 7.65 was not far behind these two groups. An ANOVA confirmed the results to be significant ($p<.01$). Levene's statistic was significant, indicating a violation of homogeneity. The result did, however, remain significant when Welch's statistic was used ($p<.01$).

Table 64

View of SSI in the Curriculum Separated by Teaching Position

		Elem, Non	Elem, Sci	Mid, Non	Mid, Sci	High, Non	High, Sci	Admin
Overall Score	N	29	18	42	23	28	19	23
	Mean	61.4	57.4	66.3	62.1	66.9	64.6	61.8
	Standard Deviation	7.92	7.17	8.96	7.71	8.96	6.90	9.80
	Significance	$F(6, 175)= 3.70$, $p=.002$.						
Perspective Score	N	29	18	42	23	28	19	23
	Mean	-1.00	-3.89	4.07	8.57	.36	8.95	7.65
	Standard Deviation	5.67	7.37	7.11	7.76	8.55	11.0	11.3
	Significance	$F(6, 175)= 8.16$, $p< .001$*						

*Violates Levene's ($p= .014$); Welch's: $p< .01$.

Table 65

Post-Hoc Tests to Explain Significance in Overall Scores for All SSI

		p value	
Group 1	Group 2	LSD	Scheffe
Elementary, Non-science	Middle, Non-science	.018	.460
Elementary, Non-science	High, Non-science	.014	.412
Elementary, Science	Middle, Non-science	.000	.036
Elementary, Science	High, Non-science	.000	.035
Elementary, Science	High, Science	.010	.349
Middle, Non-science	Administration	.043	.658
Middle, Science	High, Non-science	.044	.661
High, Non-science	Administration	.032	.590

Each instance of significance between groups can be seen in the post-hoc tests shown in Table 66. Elementary science and non-science teachers, middle school science teachers, high school science teachers, and administrators were involved in each instance of significance. Figures 3 and 4 display the results for overall view of SSI in the curriculum and the perspective of SSI that teachers think should be emphasized within the science classroom.

Table 66

Post-Hoc Tests to Explain Significance in Perspective Scores for All SSI

		p value	
Group 1	Group 2	LSD	Scheffe
Elementary, Non-science	Middle, Non-science	.013	.391
Elementary, Non-science	Middle, Science	.000	.012
Elementary, Non-science	High, Science	.000	.015
Elementary, Non-science	Administration	.000	.037
Elementary, Science	Middle, Non-science	.001	.082
Elementary, Science	Middle, Science	.000	.002
Elementary, Science	High, Science	.000	.002
Elementary, Science	Administration	.000	.005
Middle, Non-science	Middle, Science	.039	.636
Middle, Non-science	High, Science	.036	.615
Middle, Science	High, Non-science	.001	.063
High, Non-science	High, Science	.001	.068
High, Non-science	Administration	.002	.148

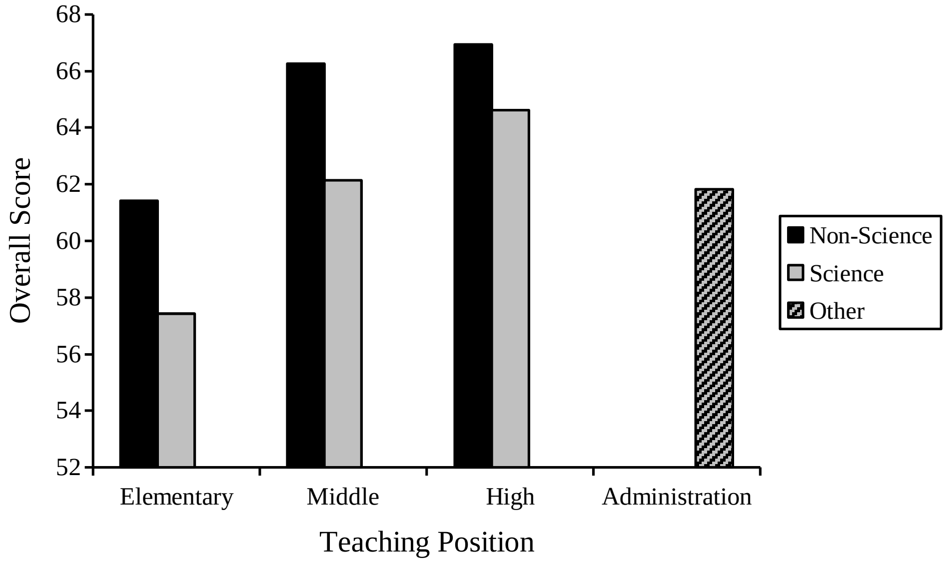

Figure 3. Willingness to include SSI in the science curriculum. Means scores representing teachers' willingness to include SSI in the curriculum arranged by teaching position.

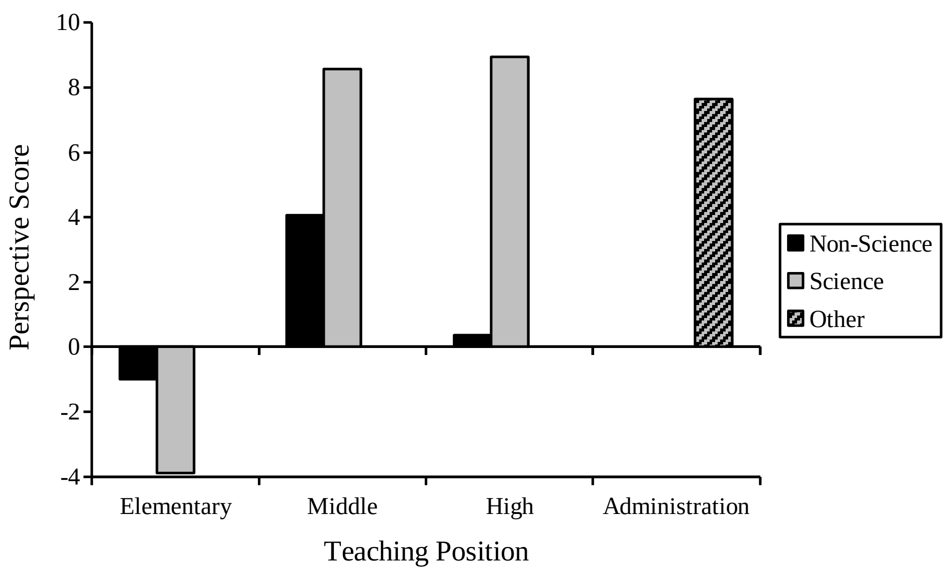

Figure 4. Preferred view of SSI covered in the science curriculum. Positive scores indicate a preference for scientific ideas; negative score indicate a preference for alternative ideas.

As shown in Table 67, the results for views of evolution were similar to the previously described overall results. Elementary school teachers were the least willing to accept the topic into the classroom. High school, non-science and middle school, non-science teachers were the most willing to accept evolution as a part of science classes. All groups were somewhat supportive of the topic as a whole, but the variation in mean scores was significant (*p*=.01). The analysis was found to violate homogeneity as seen in Levene's test (*p*= .04). Welch's test did confirm that the overall willingness to include SSI in the science classroom did vary significantly (*p*=.02). The mean scores for each group is presented in Figure 5. The post-hoc test included in Table 68 shows each instance of significance between groups. Each of these includes one of the elementary school groups.

Table 67

Summary of Overall View of Evolution in the Curriculum Arranged by Subject Taught

		Elem, Non	Elem, Sci	Mid, Non	Mid, Sci	High, Non	High, Sci	Admin
Overall Score	N	34	20	49	24	30	21	25
	Mean	18.3	19.4	21.8	20.7	21.6	20.4	20.4
	Standard Deviation	5.09	2.28	4.46	3.52	4.64	3.57	5.00
	Significance	*F*(6, 196)= 2.77, *p*=.013*						
Perspective Score	N	34	20	49	24	30	21	25
	Mean	-2.15	-5.15	.86	3.63	-.67	4.76	2.60
	Standard Deviation	4.83	5.25	4.21	3.99	5.38	5.97	5.25
	Significance	*F*(6,196)= 11.4, *p*< .001**						

*Violates Levene's (*p*= .036); Welch's: *p*= .02.
**Violates Levene's (*p*= .037); Welch's: *p*= .000.

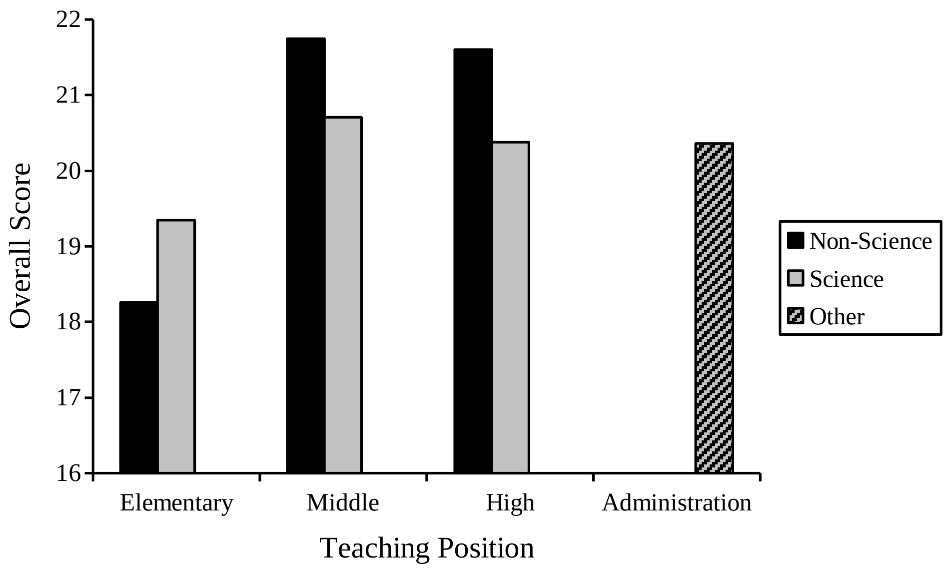

Figure 5. Willingness of educators to include SSI in the science curriculum. Means scores representing teachers' willingness to include evolution in the curriculum arranged by teaching position.

Table 68

Post-Hoc Tests to Explain Significance in Overall Scores for Evolution

		p value	
Group 1	Group 2	LSD	Scheffe
Elementary, Non-science	Middle, Non-science	.000	.047
Elementary, Non-science	Middle, Science	.035	.612
Elementary, Non-science	High, Non-science	.002	.156
Elementary, Science	Middle, Non-science	.038	.625

Table 67 includes perspective scores for each of the groups. Negative scores appear in both elementary teacher groups and among high school teachers who do not teach science. The same data is presented in Figure 6. The highest scores were seen among middle school and high school science teachers. The third most positive score was found among administrators. Each instance of significance can be seen in Table 69. Elementary school teachers appear most often in these results. In each of the remaining significant pairings secondary (middle and high school) science teachers or administrators are included.

Table 69

Post-Hoc Tests to Explain Significance in Perspective Scores for Evolution

		p value	
Group 1	Group 2	LSD	Scheffe
Elementary, Non-science	Elementary, Science	.031	.583
Elementary, Non-science	Middle, Non-science	.007	.281
Elementary, Non-science	Middle, Science	.000	.005
Elementary, Non-science	High, Science	.000	.000
Elementary, Non-science	Administration	.000	.041
Elementary, Science	Elementary, Non-science	.031	.583
Elementary, Science	Middle, Non-science	.000	.002
Elementary, Science	Middle, Science	.000	.000
Elementary, Science	High, Non-science	.002	.131
Elementary, Science	High, Science	.000	.000
Elementary, Science	Administration	.000	.000
Middle, Non-science	Middle, Science	.025	.530
Middle, Non-science	High, Science	.003	.164
Middle, Science	High, Non-science	.002	.123
High, Non-science	High, Science	.000	.023
High, Non-science	Administration	.015	.423
High, Science	Administration	.000	.898

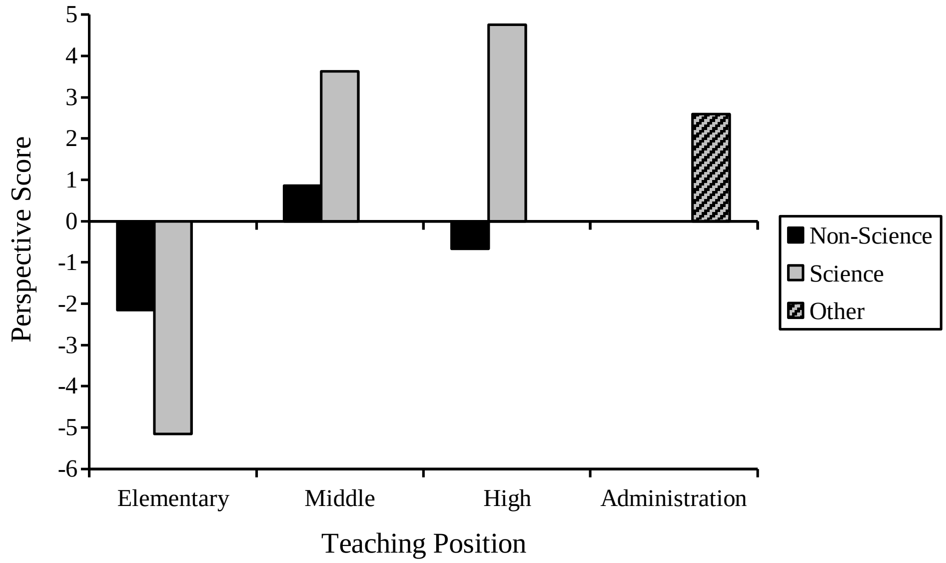

Figure 6. Preferred view of evolution covered in the science curriculum. Positive scores indicate a preference for scientific ideas; negative scores indicate a preference for alternative ideas.

Table 70 shows mean scores for each of the seven possible position groups when pro-evolution and pro-alternative scores are separated. This is the data from which perspective score was derived. Table 77 supports the data presented in Table 74. Highest scores in support of evolutionary ideas are seen among secondary science teachers and the administration group. The highest support for alternative ideas is seen among the non-science teachers and both groups of elementary teachers. ANOVA tests confirmed these results were significant ($p < .01$ for both). In both cases Levene's statistic was significant, indicating a violation of homogeneity. Welch's more robust test supported the conclusion that the displayed variation was significant. In this analysis neutral would be represented by a score of 9.

Table 70

Summary of Pro-Evolution and Pro-Alternative Perspectives

		Elem, Non	Elem, Sci	Mid, Non	Mid, Sci	High, Non	High, Sci	Admin
Pro-evolution	N	34	20	49	24	33	21	25
	Mean	8.06	7.10	11.3	12.2	10.4	12.6	11.5
	Standard Deviation	3.80	3.13	3.00	1.88	3.63	2.23	3.22
	Significance	F(6, 199)= 11.0, p< .001.*						
Pro-alternative	N	34	20	49	24	31	23	28
	Mean	10.2	12.3	10.5	8.54	11.1	7.74	8.93
	Standard Deviation	3.19	2.57	3.13	3.26	3.36	4.36	3.93
	Significance	F(6, 202)= 4.99, p< .001.**						

* Violates Levene's (p= .001); Welch's: p< .01.
** Violates Levene's (p= .029); Welch's: p< .01.

Table 71 shows the results for the analysis for views of stem cell research as a topic for the science classroom. Elementary school science teachers had the lowest score, 17.33. This was the first instance of a score below 18, which indicates that elementary school science teachers believe the topic should not be included. The highest score was seen among those high school teachers who do not teach science classes. The previous information is visually represented in Figure 7. The post hoc analysis, shown in Table 72, confirms that each of the significant comparisons included either of the extreme groups: elementary, science or high school, non-science.

Table 71

Summary of Overall View of SCR Arranged by Subject Taught

		Elem, Non	Elem, Sci	Mid, Non	Mid, Sci	High, Non	High, Sci	Admin
Overall Score	N	31	21	45	24	35	22	27
	Mean	20.9	17.3	21.8	20.2	22.7	21.6	20.6
	Standard Deviation	4.47	5.34	4.15	4.31	3.24	3.81	4.02
	Significance	$F(6,198)= 4.18$, $p=.001$.						
Perspective Score	N	31	21	46	24	36	22	27
	Mean	-.032	-.86	.73	1.04	-.028	1.55	1.56
	Standard Deviation	1.33	1.77	1.50	1.49	1.76	2.48	2.49
	Significance	$F(6,196)= 6.03$, $p<.001$ *						

* Violates Levene's ($p< .01$), Welch's: $p< .01$.

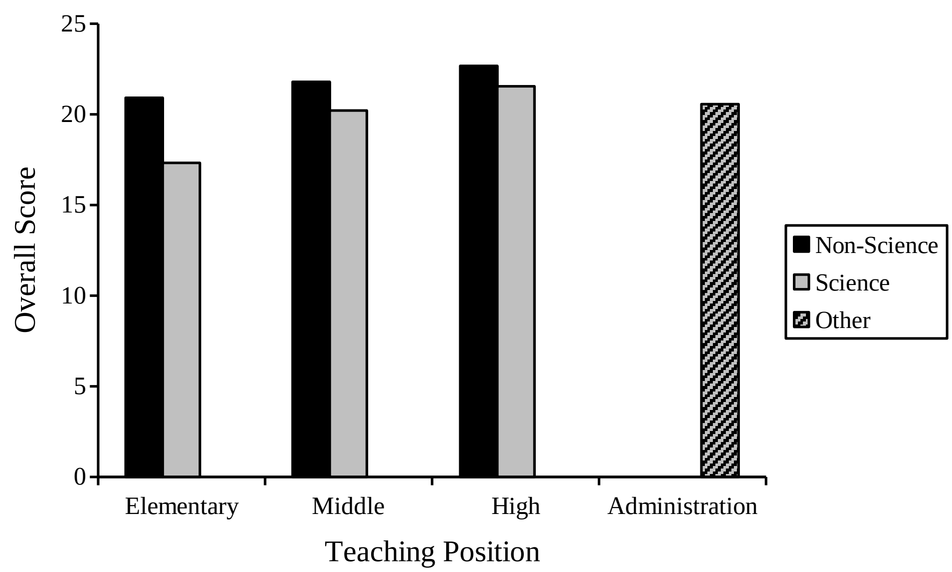

Figure 7. Willingness of educators to include SCR in the science curriculum. Mean scores representing teachers' willingness to include SCR in the curriculum arranged by teaching position.

Table 72

Post-Hoc Tests to Explain Significance in Overall View of SCR

		p value	
Group 1	Group 2	LSD	Scheffe
Elementary, Science	Elementary, Non-science	.003	.170
Elementary, Science	Middle, Non-science	.000	.015
Elementary, Science	Middle, Science	.022	.505
Elementary, Science	High, Non-science	.000	.002
Elementary, Science	High, Science	.001	.095
Elementary, Science	Administration	.009	.320
High, Non-science	Middle, Science	.026	.542
High, Non-science	Administration	.047	.679

Table 71 includes the analysis of perspective separated using teaching position as the independent variable. Three perspectives were negative: elementary, science; elementary, non-science; and high school, non-science. For this SSI a negative score indicates a preference to include the idea of protecting the rights of embryos over the benefits of stem cell research. Middle school science, high school science, and administration scored the three highest scores. Each mean for these groups was above 1. An ANOVA found these results to be significant ($p<.01$), but the analysis did violate the assumption of homogeneity ($p<.01$). Welch's statistic found the variance to be significant ($p<.01$). The perspective information is presented in Figure 8. The post-hoc analysis seen in Table 73 confirms the relationship between the three low groups and the three high groups. Middle school non-science teachers appear only when compared with the lowest group, elementary school science teachers.

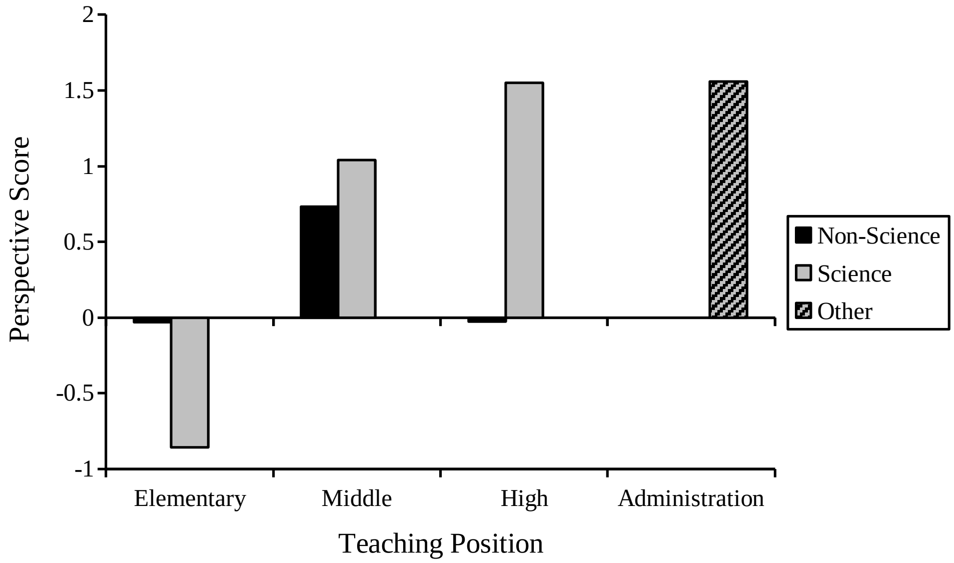

Figure 8. Preferred view of SCR covered in the science curriculum. Positive scores indicate a preference for scientific ideas; negative score indicate a preference for alternative ideas

Table 73

Post-Hoc Tests to Explain Significance in Perspective of SCR

		p value	
Group 1	Group 2	LSD	Scheffe
Elementary, Non-science	Middle, Science	.032	.586
Elementary, Non-science	High, Science	.002	.148
Elementary, Non-science	Administration	.001	.097
Elementary, Science	Middle, Non-science	.001	.094
Elementary, Science	Middle, Science	.001	.065
Elementary, Science	High, Science	.000	.006
Elementary, Science	Administration	.000	.003
High, Non-science	Middle, Science	.027	.553
High, Non-science	High, Science	.002	.125
High, Non-science	Administration	.001	.077

Table 74 shows the data for an analysis that was conducted exploring perspective scores. For this test the three questions indicating support for stem cell research and the three questions indicating special concern for embryos were separated. The results did not perfectly mimic the results for perspective seen in Table 71. Elementary school science teachers were the only group to display a perspective that did not support the inclusion of ideas supporting stem cell research. High school science had the highest level of support for stem cell research. Each group had a positive perception of pro-embryo ideas, but the elementary school science group was once again the lowest. The pro-stem cell research questions (p<.01) and the pro-embryo questions were both found to show significant variation.

Table 74

Summary of Pro-Stem Cell Research and Pro-Embryo Perspectives

		Elem, Non	Elem, Sci	Mid, Non	Mid, Sci	High, Non	High, Sci	Admin
Pro-stem cell research	N	31	21	46	24	36	22	28
	Mean	10.3	8.00	11.4	10.8	11.4	11.8	11.3
	Standard Deviation	2.37	2.77	2.06	1.98	2.00	2.42	2.34
	Significance	$F(6, 200)= 7.53$, $p< .001$.						
Pro-embryo	N	31	21	46	24	36	23	27
	Mean	10.6	9.33	10.4	9.42	11.4	9.52	9.26
	Standard Deviation	2.42	3.07	2.64	2.98	2.10	3.00	2.73
	Significance	$F(6, 200)= 2.90$, p=.010, *ns.*						

Table 75 summarizes the views educators in this study hold regarding the topic of climate change as an appropriate topic for the classroom. These results show that each group of educators believed the topic should be included in the classroom. Secondary non-science teachers were the most convinced that multiple aspects of the topic should be included. The variation in overall scores were not significant (p= .62). These mean scores and groups are also represented in Figure 9. The preferred perspective between the groups was significant (*p*=.01). The most positive perspective was found among middle school science teachers; the least positive perspective was found among high school non-science teachers. The analysis violated the test for homogeneity measure by Levene's statistic (*p*=.01), but was significant according to Welch's test (*p*=.01). Post-hoc tests shown in Table 76 found significant results when the comparisons included middle school science teachers and high school non-science teachers, the two most extreme perspectives. These results are presented graphically in Figure 10.

Table 75

View of Climate Change Arranged by Subject Taught

		Elem, Non	Elem, Sci	Mid, Non	Mid, Sci	High, Non	High, Sci	Admin
Overall Score	N	31	18	45	23	32	21	29
	Mean	21.8	21.3	22.3	21.2	22.4	22.2	21.7
	Standard Deviation	2.21	2.28	2.80	2.17	3.59	3.39	3.48
	Significance	*F*(6,192)= .738, *p*=.620, *ns*.						
Perspective Score	N	31	18	45	23	32	21	29
	Mean	1.45	2.11	2.11	3.87	.97	2.86	2.76
	Standard Deviation	1.69	2.56	2.72	3.68	2.68	3.18	3.49
	Significance	*F*(6,192)=3.00, *p*= .008*						

* Violates Levene's (*p*=.006); Welch's: *p*=.022.

Table 76

Post-Hoc Tests to Explain Significance in Overall Scores

		p value	
Group 1	Group 2	LSD	Scheffe
Middle, Science	Elementary,_Non-science	.003	.162
Middle, Science	Elementary,_Science	.053	.707
Middle, Science	Middle, Non-Science	.018	.461
Middle, Science	High, Non-science	.000	.039
High, Non-science	High School, Science	.020	.488
High, Non-science	Administration	.016	.438

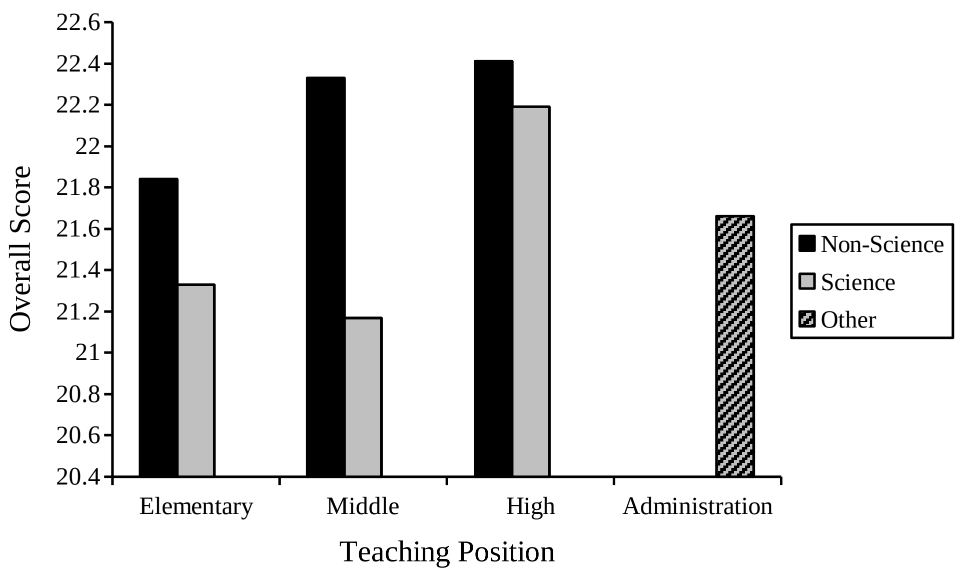

Figure 9. Willingness of educators to include climate change in the science curriculum. Overall opinion of teachers concerning climate change in the curriculum.

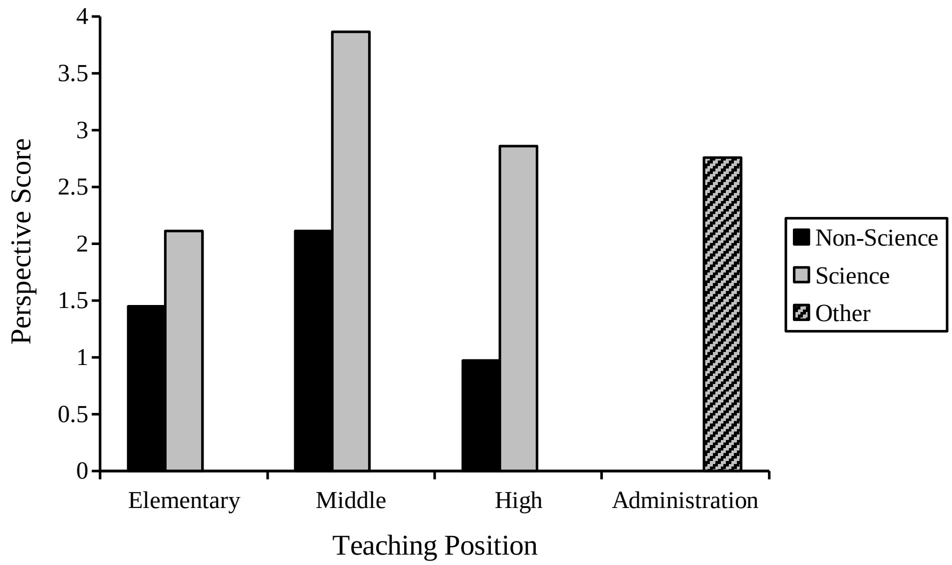

Figure 10. Preferred view of climate change covered in the science curriculum. Positive scores indicate a preference for scientific ideas; negative scores indicate a preference for alternative ideas.

The pro-climate change and anti-climate change questions were separated for the data presented in Table 77. Each of the groups had a view in support of including ideas of climate change science. The analysis found the pro-climate change responses were not significantly different (p=.25). The anti-climate change results were significantly different (p=.03), with the least positive responses being seen among all science teachers and the administration group.

Table 77

Summary of Pro-Climate Change Versus Anti-Climate Change Arranged by Subject Taught

		Elem, Non	Elem, Sci	Mid, Non	Mid, Sci	High, Non	High, Sci	Admin
Pro-climate change	N	31	19	47	24	32	21	29
	Mean	11.7	11.6	12.3	12.5	11.7	12.5	12.2
	Standard Deviation	1.20	1.54	1.70	1.69	2.28	2.09	2.16
	Significance	*F*(6,196)= 1.31, *p*= .253, *ns.*						
Anti-climate change	N	31	18	46	23	32	22	30
	Mean	10.2	9.61	10.1	8.65	10.7	9.55	9.50
	Standard Deviation	1.56	1.88	2.20	2.48	2.20	2.54	2.70
	Significance	*F*(6,195)= 2.35 , *p*= .032.						

Support for the Science and Evidence behind Each SSI

Participants in this study have views of evolution that varied considerably. Table 78 shows the distribution of views concerning evolution as a science. Of the educators in this study, 46.4% were supportive of the science of evolution. The question used to gather these data specifically asked respondents to indicate their level of support for evolution as “a credible field of science.” Of the remaining 53.7% of participants, 28.3% were in opposition and another 25.4% remained undecided. Table 79 shows the views educators hold regarding the evidence used in support of evolution. Over one-third (38.7%) of educators in this survey did not believe the science in question was both “accurate and unbiased.” An additional 28.3% were undecided. This left only one-third (33.00%) who were in support of the evidence used to support evolution.

Table 78

View Evolution as a Credible Field of Science

	Frequency	Percent
Strongly Oppose	40	19.5%
Oppose	18	8.8%
Neutral	52	25.4%
Support	50	24.4%
Strongly Support	45	22.0%

Table 79

The Evidence Used to Support Evolution is Both Accurate and Unbiased

	Frequency	Percent
Strongly Disagree	44	20.8%
Disagree	38	17.9%
Neutral	60	28.3%
Agree	39	18.4%
Strongly Agree	31	14.6%

Tables 80 and 81 present data for the same questions discussed in the previous paragraph; in this instance results are separated by teaching position of the respondent. Support for evolution as a credible field of science is very limited among elementary school teachers. In each case less than 20% were willing to respond affirmatively. Among secondary teachers the results found greater levels of support for evolution. Only high school non-science teachers had a result that found less than 50% support for evolution. The data presented in Table 81 found an even more clear distinction. Three-fourths (75%) of elementary school teachers who teach science believe the evidence used in support of evolution is not "accurate and unbiased." For this question only secondary science teachers had a majority in support of the evidence for evolution.

Table 80

View Evolution as a Credible Field of Science Separated by Teaching Position

	Elem, Non	Elem, Sci	Mid, Non	Mid, Sci	High, Non	High, Sci	Admin
Oppose	48.4%	55.0%	19.1%	8.7%	39.4%	4.5%	24.1%
Neutral	32.3%	35.0%	23.4%	21.7%	18.2%	27.3%	24.1%
Support	19.4%	10.0%	57.4%	69.6%	42.4%	68.2%	51.7%

Table 81

The Evidence Used to Support Evolution is Both Accurate and Unbiased Separated by Teaching Position

	Elem, Non	Elem, Sci	Mid, Non	Mid, Sci	High, Non	High, Sci	Admin
Disagree	55.9%	75.0%	30.6%	12.5%	50.0%	17.4%	32.1%
Neutral	32.4%	15.0%	36.7%	37.5%	23.5%	21.7%	21.4%
Agree	11.8%	10.0%	32.7%	50.0%	26.5%	60.9%	46.4%

Over one-third of respondents (38.8%) support the use of embryos in medical research. Fewer (28.7%) oppose the use of embryos and 30.8% remain undecided. The full results can be seen in Table 82. Table 83 shows a more clear result for views concerning the possibilities offered by stem cell research. A clear majority (58.7%) agreed or strongly agreed that the practice offers the possibility for "significant medical advances." Only 12.5% disagreed with this possibility, while 27.5% remained undecided.

Table 82

Support for the Use of Embryos in Medical Research

	Frequency	Percent
Strongly Oppose	26	12.4
Oppose	34	16.3
Neutral	68	30.8
Support	53	25.4
Strongly Support	28	13.4

Table 83

Stem Cell Research Offers the Possibility for Significant Medical Advances.

	Frequency	Percent
Strongly Disagree	10	4.8
Disagree	16	7.7
Neutral	57	27.5
Agree	85	41.1
Strongly Agree	39	17.6

Tables 84 and Table 85 show somewhat similar results when the previous questions are separated by teaching position. There is neither clear support for nor opposition to the use of embryos in medical research. The administrator group was the only one to receive 50% support for the practice, followed closely by high school science teachers. Elementary science teachers had the largest opposition to the practice. Elementary school teachers were the only groups not convinced that the use of embryos offered the possibility of medical advances. As seen in Table 85, high school science teachers were clearly convinced that the practice offers significant possibilities.

Table 84

Support for the Use of Embryos in Medical Research Separated by Teaching Position

	Elem, Non	Elem, Sci	Mid, Non	Mid, Sci	High, Non	High, Sci	Admin
Oppose	32.3%	47.6%	21.7%	25.0%	30.6%	26.1%	25.0%
Neutral	38.7%	38.1%	32.6%	33.3%	33.3%	26.1%	25.0%
Support	29.0%	14.3%	45.7%	41.7%	36.1%	47.8%	50.0%

Table 85

Stem Cell Research Offers the Possibility for Significant Medical Advances Separated by Teaching Position

	Elem, Non	Elem, Sci	Mid, Non	Mid, Sci	High, Non	High, Sci	Admin
Oppose	25.8%	31.6%	10.9%	8.3%	2.8%	4.3%	10.7%
Neutral	29.0%	42.1%	23.9%	29.2%	33.3%	8.7%	28.6%
Support	45.2%	26.3%	65.2%	62.5%	63.9%	87.0%	60.7%

Few respondents (7.3%) described themselves as opposed or strongly opposed to the science of climate change. A more significant 27.7% took a neutral perspective, but most support or strongly support the issue. These results can be seen in Table 86. Table 87 shows a more divided belief. More than a quarter (26.5%) of educators surveyed did not believe the evidence used to support climate change was both “accurate and unbiased.” Larger percentages (35.8%) of those in the study were in support of the evidence, but the largest percentages were found in the undecided category.

Table 86

Support for the Science of Climate Change

	Frequency	Percent
Strongly Oppose	7	3.4
Oppose	8	3.9
Neutral	57	27.7
Support	97	47.1
Strongly Support	37	18.0

Table 87

Evidence Used to Support Climate Change is Both Accurate and Unbiased

	Frequency	Percent
Strongly Disagree	13	6.4
Disagree	41	20.1
Neutral	77	37.7
Agree	50	24.5
Strongly Agree	23	11.3

The majority of individuals in this study supported the science of climate change. The percentage within each teaching category can be seen in Table 88. Middle school science teachers had an especially positive view. Elementary teachers who did not teach science were the only category for which the percentage of support was below one-half. The data for accurate and unbiased evidence, seen in Table 89, found a less supportive view of science. Participants were asked to indicate their level of support for the idea that the evidence for climate change is both “accurate and unbiased.” High school science teachers represented the only category for which over half of the individuals were in agreement. Support among elementary teachers was especially low.

Table 88

Support for the Science of Climate Change Separated by Teaching Position

	Elem, Non	Elem, Sci	Mid, Non	Mid, Sci	High, Non	High, Sci	Admin
Oppose	3.2%	10.5%	4.2%	0.0%	18.8%	4.5%	10.0%
Neutral	58.1%	31.6%	25.0%	8.3%	31.2%	27.3%	10.0%
Support	38.7%	57.9%	70.8%	91.7%	50.0%	68.2%	80.0%

Table 89

Evidence Used to Support Climate Change is Both Accurate and Unbiased

	Elem, Non	Elem, Sci	Mid, Non	Mid, Sci	High, Non	High, Sci	Admin
Disagree	25.8%	31.6%	18.8%	25.0%	43.8%	18.2%	25.0%
Neutral	54.8%	52.6%	45.8%	25.0%	25.0%	18.2%	35.7%
Agree	19.4%	15.8%	35.4%	50.0%	31.2%	63.6%	39.3%

Decision Makers and Sources of Influence

Participants were asked to select from a list those individuals who should be responsible for decision making. Respondents were able to select more than one choice. The percentage of individuals who chose each decision maker is shown in Table 90. The highest percentages were consistently seen among scientists and teachers. Low percentages were seen among state and national curriculum planners and school boards. Table 91 lists the order of the most frequent responses for each teaching position. Scientists and teachers are consistently seen in the first or second position, except for the topic of evolution. In this instance elementary teachers and high school teachers who do not teach science believe parents should take on a more prominent role.

Table 90

View of Who Should be Responsible for Decision Making for Each SSI

	Evolution	SCR	Climate
Scientists	49.3%	54.8%	59.7%
Teachers	57.0%	56.1%	56.6%
Local Adminsitration	37.1%	38.0%	34.8%
School Boards	24.4%	22.2%	17.2%
Parents	42.5%	37.1%	24.9%
State Curriculum	31.2%	32.6%	31.7%
National Curriculum	27.1%	28.1%	26.7%

Table 91

View of Who Should be the Decision Makers Separated by Teaching Position

SSI	Decision-maker	Total	Elem, Non	Elem, Sci	Mid, Non	Mid, Sci	High, Non	High, Sci	Admin
Evolution	Scientist	2	4	5	1	1	3	1	2
	Teacher	1	1	2	2	2	1	2	1
	Local Admin	4	3	2	4	5	3	6	5
	School Board	7	5	4	5	5	5	7	7
	Parents	3	2	1	3	5	2	5	4
	State	5	6	6	6	3	6	3	3
	Nation	6	7	7	7	3	7	4	6
SCR	Scientist	2	2	4	1	1	2	1	1
	Teacher	1	1	1	2	2	1	2	1
	Local Admin	3	3	3	4	3	2	7	4
	School Board	7	5	5	7	4	5	6	7
	Parents	4	4	1	5	4	4	5	4
	State	5	6	6	3	4	6	4	1
	Nation	6	7	7	5	4	7	3	6
Climate Change	Scientist	1	2	1	1	1	3	1	1
	Teacher	2	1	1	2	2	1	2	2
	Local Admin	3	3	3	3	4	2	5	4
	School Board	7	5	7	7	6	5	7	7
	Parents	6	4	4	6	7	4	5	5
	State	4	6	5	4	3	5	3	2
	Nation	5	7	6	5	4	7	3	5

Respondents were asked to select from a list the sources of information that had been most important to their decision making regarding all SSI. The available choices were academic sources, religious sources, TV, non-academic websites, other media, family, and friends. Participants could make more than one selection. The number of times each option was selected can be seen in Table 92. The percentages shown represent the percentage of total respondents selecting each source of information. The majority (91.9%) selected academic sources as an important information source. The second most important source was television, followed by religious sources and other media. Table 93 shows the percentage selecting each option separated by teaching position. Academic sources remain high across each category. Elementary teachers chose religious sources at somewhat higher percentages than the remaining categories.

Table 92

Sources of Information Most Important for Decision Making

	Academic	Religious	TV	Websites	Media	Family	Friends
Frequency	203	48	56	19	48	30	16
Percent of total respondents	91.9%	21.7%	25.3%	8.6%	21.7%	13.6%	7.2%

Table 93

Sources of Information for Decision Making Arranged by Teaching Position

Source	Elem, Non-sci	Elem, Sci	Mid, Non-sci	Mid, Sci	High, Non-sci	High, Sci	Admin
Academic	94.6%	95.2%	90.0%	100.0%	86.1%	95.7%	86.7%
Religious	32.4%	42.9%	14.0%	16.7%	25.0%	13.0%	13.3%
TV	27.0%	19.0%	36.0%	29.2%	16.7%	13.0%	26.7%
Websites	13.5%	14.3%	6.0%	12.5%	0.0%	4.3%	13.3%
Media	21.6%	38.1%	28.0%	29.2%	8.3%	13.0%	16.7%
Family	16.2%	14.3%	16.0%	25.0%	5.6%	8.7%	10.0%
Friends	2.7%	9.5%	12.0%	12.5%	0.0%	8.7%	6.7%

Support for SSI Legislation

Over half (51.6%) of total respondents answered the open-ended portion of the questionnaire. Respondents were asked to describe their support for a state legislation emphasizing broad coverage of SSI. Tennessee House Bill 368 was used as a specific piece of legislation to discuss a broader point. The specific document to which participants were asked to respond can be seen in Appendix B. Of the 122 who did indicate their support for or opposition to the discussed legislation, 55.3% answered in the affirmative. Table 94 provides a more detailed view of the number of respondents in support and those opposed.

Table 94

Percentage of Respondents Who Supported and Opposed SSI Legislation

	Frequency	Percent
Support Bill	63	55.3%
Oppose Bill	51	44.7%

The indicated support for the SSI legislation was separated by teaching position and is presented in Table 95. Some trends emerged from these data, which were confirmed to be significant using a chi-square analysis (*p*=.04). Three groups were opposed to laws which protect the inclusion of alternative perspectives in the science curriculum. These groups were elementary science teachers, high school science teachers, and administrators. Four groups supported this legislation: elementary non-science teachers, middle school non-science teachers, middle school science teachers, and high school non-science teachers. Especially high levels of support were seen among elementary teachers who do not teach science and high school teachers who do not teach science.

Table 95

Level of Support for SSI Legislation Separated by Teaching Position

		Elem, Non	Elem, Sci	Mid, Non	Mid, Sci	High, Non	High, Sci	Admin
Support Bill	Count/ Expected	11/ 7.7	6/ 7.7	13/ 13.8	9/ 8.3	11/ 7.2	8/ 9.4	5/ 8.8
	% of Group	78.6%	42.9%	52.0%	60.0%	84.6%	47.1%	31.2%
Oppose Bill	Count/ Expected	3/ 6.3	8/ 6.3	12/ 11.2	6/ 6.7	2/ 5.8	9/ 7.6	11/ 7.2
	% of Group	21.4%	57.1%	48.0%	40.0%	15.4%	52.9%	68.8%

χ^2(6, N=114)=12.92, *p*=.04.

A significant result was seen when support for SSI legislation was compared with overall score and perspective. Those who supported the bill did not have a significantly higher level support for the inclusion of SSI overall (*p*=.29) (see Table 96). Perspective scores and reasoning quality were also found to have a lack of variation between those who support the legislation and those who oppose it (*p*=.72 and *p*= .43).

Table 96

View of SSI in the Curriculum Separated by Support for SSI Legislation

		Support	Oppose
Overall score	N	54	46
	Mean	64.9	63.2
	Standard Deviation	8.29	7.52
	Significance	*t*(98)= 1.07, *p*=.29, *ns.*	
Perspective score	N	54	46
	Mean	5.39	4.63
	Standard Deviation	10.9	9.99
	Significance	*t*(98)= .36, *p*= .72, *ns.*	

Reasoning Quality

Reasoning quality was measured for each individual who responded to the open-ended questions. The rubric described by Sadler and Donnelly (2006) was used to guide this analysis. Due to nature of the analysis, reasoning quality scores are largely qualitative in nature, but certain statistical procedures were used to identify any potential factors associated with views of SSI in the classroom.

For each of the three argument questions the displayed reasoning quality was determined. The initial question asked participants to describe their beliefs regarding legislation like Tennessee House Bill 368. This question did not specifically ask respondents to form an argument, but many responses took the form of an argument. Thus, the first and second question were used together to describe the argument quality of each individual. The rubric shown in Table 9 was used to guide the scoring of each response. Frequency for each score can be seen in Table 97.

Table 97

Reasoning Quality Frequencies for Argument Production

Score	Frequency	Percent
0	1	.9
1	6	5.3
2	64	56.1
3	63	37.7

A score of zero was given to any responses that were blank or had no relevant points. Only one response was given this score. This individual simply wrote “Yes” for the first question and “No” for the second question. Six participants received an argument score of 1. To receive this score the response was not meaningful, no argument was provided, or the argument was severely incomplete. One participant wrote, “I don't get involved in politics.” This response was given a score of 1. There is an indication that the respondent views the argument as a political issue and might argue against Bill 368 on the basis of the politics, but the argument is incomplete.

A higher score of 2 was given to responses that provided an argument, but failed to support that argument. For those responses providing an argument, including reasoning, and providing a framework for supporting their view the highest score of 3 was awarded. SSI are social and scientific in nature; therefore, the arguments did not need to be based on empirical evidence. The response did need to provide a well-defined criterion for their reasoning. For those who did provide what they believed to be factual information the validity of these claims was not evaluated. The argument from respondent 207 and respondent 113 illustrate two different reasoning qualities from individuals using the same lens.

207: To not give other theories a chance is wrong and wouldn't be the scientific way.

113: It gives an opportunity for all sides of science to be explored and tested. The Scientific Method can be used: systematic observation, measurement, and experiment, and the formulation, testing, and modification of hypotheses. This allows for the truth. . . . Everyone deserves to test the scientific theory.

Respondent 207 argues that the bill should be passed to ensure that multiple theories are explored because this is "the scientific way." It is likely that "the scientific way" referred to is actually the scientific method. Respondent 113 illustrates this argument more eloquently and with support not provided in the first argument. The proposed bill should be implemented to ensure that the scientific method can be explored. The argument provided by 113 even includes details addressing specific parts of the scientific method.

The ability to argue from multiple perspectives was evaluated using one of the questions in the open-ended portion of the assessment. This prompt asked respondents to form an argument with which they do not agree. As can be seen in Table 98, scores of 2 and 3 were less common for this aspect of reasoning

Table 98

Reasoning Quality Frequencies for Multiple Perspective

Score	Frequency	Percent
0	20	17.5
1	38	33.3
2	35	30.7
3	21	18.4

. In numerous instances, the response was simply a reflection of the view stated in the previous question. Such misconceptions were not an indication of an ability to produce an argument from an opposing point of view and were given a score of 1. The following is one example:

> 24: I believe that everyone has a right to their belief system, but I don't think that teachers who are so impressionable and so accountable to administration, which is accountable to the community, should have the power to influence my child's belief system.

There is no indication that the use of the word "I" is the participant using a literary device and arguing as the narrator of someone else's opinion. Responses to the other questions support the conclusion that Participant 24 is simply restating his/her own opinion. Other participants given a score of 1 indicated they simply could not develop an argument from opposing perspective. Participant 206 offers one example:

> 206: There is NO argument that would convince me that high school students should not be given information to enable them to make informed decisions about controversial topics.

Some of those receiving a score of 2 provided an implied argument. These responses argued from their own perspective, while providing some insight into what they believe a possible counter-position would include. The response from the individual labeled 259 offers one such response:

> 259: I am a scientist, trained in objectively studying and teaching scientific information based on facts and evidence. I am not trained in non-objective

> subjects for which there is no hard evidence. The people best suited to train students in faith are the families, not science teachers.

In 259's argument it can be inferred that those who oppose his/her view do so in the light of a "faith." While implied this is not explicitly included. Others receiving a score of 2 offered a possible perspective which could be offered in opposition to their own view, but included no direct arguments. This can be seen when 182 writes, "that the position conflicts with their religious and ethical beliefs."

Those receiving a score of 3 for multiple perspectives offered a cogent viewpoint that was in opposition to their own belief. These statements did not briefly mention an opposing view or provide an implied argument and then state their reasons for disagreement. Those receiving a score of 3 provided a clear view from conflicting position. Respondents 236 and 184 offer examples of this type of reasoning:

> 236: Students don't have the intellectual maturity to decide for themselves and should not be confused with opposing ideas.
>
> 184: Others may argue that due to their years of scientific study, comparatively students are not qualified to form opinions on matters of such polarity and social gravity.

Rebuttal scores, seen in Table 99, were similar to multiple perspective scores. This measure was intended to evaluate the respondents' ability to counter an argument. The previously discussed question addressing multiple perspectives was designed to measure the ability to form an opposing argument with the rebuttal question intended to counter that argument. In some instances the participating educator did not provide a response or the response for the multiple perspective question was limited. This did not necessitate a low rebuttal score. A high rebuttal score could be accomplished if the response supplied an implied argument and then argued against that position. Such a response did not have a well-reasoned opposing position, thus achieving a low multiple perspective score, but such a response did successfully counter an opposing view, thus achieving a high rebuttal score. Respondent 264 offers one such example. This response begins with a realization that “I am not sure I have been following the directions:”

> 264: Students can have alternate understandings, from other funds of knowledge, that might not coincide. But, in a democracy, it is up to each individual student to decide what they believe, understand, and how/why they personally substantiate these ideas. Science is one way in which they can understand the world. It does not support the concept of creationism or the idea that climate change is not currently occurring. Stem cells, that’s a little more touchy! But arguing whether or not stem cells should be used in medical [treatments] is not a scientific question. Understanding the science of stem cells, and potential for research purposes, is a scientific endeavor.

The previous argument was given a score of 3 because there is an implication that a couner-argument has been considered. Participant 264 seems to believe that there are multiple ways to “understand the world.” He/she then argues against these undescribed other ways of understanding for climate change and evolution and provides a more nuanced view for stem cell research. Respondent 264 received a score of 1 for multiple perspective and a score of 3 for rebuttal.

Table 99

Reasoning Quality Frequencies for Rebuttal Score

Score	Frequency	Percent
0	24	21.1
1	22	19.3
2	31	27.2
3	37	32.5

A number of educators (21.1%) gave unhelpful responses, which were given a value of 0. These responses include those that were blank or had unhelpful fillers, such as question marks or "N/A." Other answers in this category included "hard question" and "not sure".

Some of those educators given a score of 1 offered a response that was personal in nature and not a genuine argument in opposition to another opinion. Respondent 62 wrote, "I am not a very controversial person. I often think that people may believe the way they want to." Other responses given a score of 1 were well reasoned arguments, but were not in response to a counter-position. These individuals simply reused a previously supplied opinion. For example, Participant 5 wrote in a previous question, "I believe in giving students the knowledge and allowing personal decisions to come from it." Then, as a rebuttal argument, the same respondent said, "students need the ability to take knowledge given, research more information, use prior knowledge and personal views to take a stand and present an argument."

Those who received a score of 2 offered a cogent response, but the argument was incomplete, or did not directly respond to a counter-position. In some instances a counter-position was not given, but the rebuttal response does provide an argument that was not previously mentioned by that participant. The response is not simply a reiteration of a previously described view. For one of the previous reasons the following were given a score of 2:

> 23: One has nothing to do with the other and I could actually argue that intelligent design was accomplished through scientific evolution.
>
> 82: Quote from the Bible and state my belief that this is the Word of God and cannot be disputed by anyone in my mind.
>
> 202: The rights of students and parents should always be considered first. It is not public education or political parties [sic] views that influence the values of our children. It is still every American's right to develop their own religious and scientific viewpoint. It is a teacher's responsibility to teach facts based on scientific research. Not their political viewpoints.

Nearly one-third (32.5%) of the respondents received a reasoning score of 3. These individuals made an argument which was relevant, responded to a counter-position, and included supporting material. Due to the nature of the topics, support criteria did not need to be based on verifiable data. The response should merely refer to the framework used to support belief. Many individuals supported the inclusion of the proposed legislation due to a belief that all ideas should be included and dissected. Such a response does not need to be supported with evidence related to which claims concerning SSI they believe to be accurate. The following responses give examples of individuals arguing from differing perspectives. Respondents 119 and 56 each believe ideas can be openly discussed in the classroom, but 119 supported the legislation, while 56 opposed it. These differences can be seen in the responses below. The participants labeled 146 and 133 both argue that scientific evidence can be used to support their claims; interestingly, their view of the science pushes them toward diametrically opposed positions.

> 119: Allow them to discuss, critique, and explore both. Let them THINK. Children today, as a whole, struggle with critical thinking. They desire to have information "spoon fed" to them and are often given immediate results without much thinking taking place. This is a wonderfully controversial topic that evokes a great deal of thought, study, and critical thinking. What a wonderful thing!
>
> 56: This comes down to worldviews. Either we believe in a universe by some sort of design or a universe without any design and completely by accident. Even if it is directed somewhat it is directed by an outside being. Evolution happens and that should be taught, but to deny someone the right to discuss their views is wrong. I am not for a formal curriculum on religion in public schools, but I am not against discussing such things within a classroom if the students bring it up.
>
> 146: I would point them to sources like the Institute for Creation Research and scientists like Dr. David Menton who are both Christians and scientists. There are just as many if not more loop holes and loose edges in the Big Bang Theory and human evolution as there are in the Creation Theory.
>
> 133: There is virtually no scientific controversy among the overwhelming majority of researchers on the core facts. This bill could lead to too much personal bias in teaching the concepts.

Tables 100 and 101 show the frequencies and descriptive results for overall reasoning quality. Less than one-quarter (24.5%) of respondents received a score of 8 or

9. The mean value for the analysis was a 5.52, indicating the average result for each measure was below 2. Table 102 shows the reasoning quality separated by view of legislation. This result indicates that no significant variation exists in the reasoning quality between those who support the legislation and those who oppose it.

Table 100

Frequencies for Overall Reasoning Quality

Score	Frequency	Percent
1	3	2.6
2	10	8.8
3	10	8.8
4	19	16.7
5	15	13.2
6	14	12.3
7	15	13.2
8	16	14.0
9	12	10.5

Table 101

Descriptive Statistics for Reasoning Quality

N	114
Minimum	1
Maximum	9
Mean	5.52
Standard Deviation	2.26

Table 102

Reasoning Quality Separated by View of Legislation

		Support	Oppose
Reasoning Quality	N	63	51
	Mean	5.40	5.67
	Standard Deviation	2.18	2.36
	Significance	$t(112)$= -.633, p=.528, *ns.*	

In attempting to evaluate the relationship between reasoning quality and overall view of SSI in the curriculum two linear regression analyses were conducted. The first linear regression analysis compared reasoning quality with overall view of SSI in the curriculum. Reasoning quality did not significantly predict overall score, $R^2 = .002$, $F(1, 98) = .166$, $p = .684$. In addition, reasoning quality did not explain a significant proportion of the variation in overall scores, $\beta = .145$, $t(98) = .408$, $p = .684$. Similar results were seen for perspective score. Reasoning quality did not significantly predict perspective score, $R^2 = .009$, $F(1, 98) = .926$, $p = .338$. Reasoning quality also did not explain a significant proportion of the variation in perspective scores, $\beta = .448$, $t(98) = .962$, $p = .338$. It seemed from my results that reasoning quality did not vary with overall view of SSI in the curriculum and the preferred position of each respondent.

To examine the impact of content knowledge on reasoning quality, reasoning quality scores were separated using number of college science courses taken as the independent variable. The results of this analysis can be seen in Table 103. These data do not show a significant difference between any of the groups. In a somewhat similar test the reasoning quality of educators was separated by teaching position. These results are shown in Table 104. High school non-science teachers displayed the highest reasoning quality, followed by high school science teachers. Elementary non-science teachers had the lowest scores, but the variation was not significant (p=.62).

Table 103

Summary of Reasoning Quality Arranged by College Science Courses

		Low (0-2)	Mid (3-11)	High (12+)
Reasoning Quality Score	N	31	32	51
	Mean	5.90	5.75	5.65
	Standard Deviation	2.37	2.81	2.62
	Significance	*F*(2,111)= .093, *p*=.911, *ns*.		

Table 104

Summary of Reasoning Quality Arranged by Subject Taught

		Elem, Non	Elem, Sci	Mid, Non	Mid, Sci	High, Non	High, Sci	Admin
Reasoning Quality Score	N	14	14	25	15	13	17	16
	Mean	4.79	5.50	5.20	5.80	6.31	5.94	5.31
	Standard Deviation	2.12	2.07	2.60	2.54	1.84	2.30	2.02
	Significance	*F*(6,107)= .743, *p*=.616, *ns*.						

Decision-Making Lenses

The evaluation of decision-making lenses found several distinct types, which were placed in four large categories as shown in Table 105. Three of these category names provide insight into the lens being discussed. Those within education argued from a perspective which focused on SSI in the classroom, while the science lens focused on the validity of the science supporting the stated opinion. The third category, social and religious, included those arguments focused on the impact and role of social and/or religious institutions. The last category was a catch-all group, which primarily included legislative and logistic or practical concerns. All of these lenses will be explained in greater detail later in this work.

Table 105

Frequency of Usage for Each Decision Making Lens

Lens:	Frequency	Percent
Education (1)	86	75.4%
Science (10)	36	31.6%
Religion/Social (100)	28	24.6%
Other Lenses (1000)	19	16.7%

Tables 106 and 107 illustrate interactions among responses. Most often (58.4%) responses were only placed in a single category. Thirty-three percent of respondents used two decision-making lenses and another 8% used three categories. Of those using two or more lenses, science and education were found together most often. Religion and science appeared together only 6.2% of the time.

Table 106

Number of Lenses Used by Each Participant

No. of Lenses	Frequency	Percent
1	66	58.4%
2	38	33.3%
3	9	8.0%
0	1	.9%

Table 107

Frequency of Lens Use among Participants

Lens:	Frequency	Percent
Education (1)	40	35.1%
Science (10)	5	4.4%
Science and Education (11)	22	19.3%
Religion (100)	9	7.9%
Religion and Education (101)	11	9.6%
Religion and Science (110)	1	.9%
Religion, Science, and Education (111)	6	5.3%
Other Lenses (1000)	12	10.5%
Other and Education (1001)	4	3.5%
Other, Science, and Education (1011)	2	1.8%
Other, Religion, and Education (1101)	1	.9%

Educational Lens

One lens which emerged from the examination of answers was educational in nature. These individuals were concerned with the SSI instruction, specifically how and why materials should be included in or excluded from the science classroom. As seen in Table 108 the majority of educators (75.4%) employed some aspect of education in their arguments relating to the proposed legislation. Among those using this lens support for the legislation was 62.8%. As can be seen in Table 109, this was higher than the percentage of support among those who used other lenses.

Table 108

Use of Education Lens in Decision Making

	Frequency	Percent
Used Education Lens	86	75.4%
Didn't Use Education Lens	28	24.6%

Table 109

Support for Legislation among Those Using the Education Lens in Decision Making

	Support for Legislation	
	Frequency	Percent
Used Education Lens	54	62.8%
Used only other lenses	9	32.1%

Arguments taken from respondents 194, 169, and 183 provide examples of the educational lens for decision making. These responses focus on education and what should be taught. This type of argument typically focuses on the information that should be presented in the classroom. This type of reasoning was often accompanied by underlying reasoning which would fall into another lens, but such supporting material was not required. Arguments designated as using an educational lens emphasized what should be taught concerning SSI.

> 194: I feel that the role of education is to present scientifically accepted facts.
>
> 169: Students should be able to evaluate both sides of the issue and come to a reasonable conclusion that is based on belief systems on both sides of the issue.
>
> 183: Present all views and let the students and their parents decide their own views.

Educational lens was not a significant indicator of overall score or perspective score (see Table 110). There was an indication that those employing an educational lens did have scores that were higher for reasoning quality as compared to their counterparts who used a different perspective (p= .003). To further explain aspects of the educational lens this broad category was separated into different perspectives.

Table 110

Scores Separated by Use of Education Lens in Decision Making

		Education	Other
Overall score	N	79	22
	Mean	64.7	62.2
	Standard Deviation	8.13	6.89
	Significance	*t*(99)= 1.29, *p*=.199, *ns*.	
Perspective score	N	78	22
	Mean	4.84	6.59
	Standard Deviation	10.6	10.1
	Significance	*t*(99)= -.696, *p*= .488, *ns*.	
Reasoning Quality	N	86	28
	Mean	5.87	4.43
	Standard Deviation	2.24	1.97
	Significance	*t*(112)= 3.04, *p*=..003.	

Within the educational lens three distinct modes of thought emerged (see Table 111). The largest group (40.7%) proposed arguments focused on critical thinking. Of those promoting critical thinking 97% would support bills like Tennessee House Bill 368. The reason for this is seen when those arguments are examined. Those promoting critical thinking do so with the view that all material should be presented and the individual learner should decide what is accurate. Individuals 89 and 139 provide such responses:

> 89: The goal of a teacher should be to encourage thinking. Teachers should allow the students to compare and contrast varying views on controversial topics.
>
> 139: I feel that students have the right to be informed about these scientific ideas at hand. This empowers them with information in turn assisting them in making

educated opinions, broadening their knowledge, critical thinking skills, and evaluating skills.

The second largest group with the educational lens promoted the inclusion of ideas which are supported by science in the science curriculum. Many of these responses were also included in the science lens mentioned later. The distinction between these two lenses was that the science lens focuses on the underlying science, while the education lens focuses on classroom practices or what “should” be taught. This group would not, however, vote consistently against Tennessee House Bill 368. As can be seen in Table 112, 24.2% would support the legislation on grounds that science justifies the inclusion of these alternative ideas. Respondent 81 offers the view that such legislation should not be implemented because science supports one perspective and the other ideas are based on “pseudoscience.”

> 81: I don't believe that bills such as these promote balanced science in schools. Science has been balanced through the experimental and peer review process. There is no need to politicize it with other types of pseudoscience, or non-science, being portrayed as the “balanced” approach.

Number 11 writes from the opposite perspective. He or she believes science supports aspects of alternative perspectives. Thus, these ideas should be included in the classroom. The accuracy of the supporting statement might be questioned by some, but this was not the purpose of my work.

> 11: Science presented in classrooms is usually limited to widely accepted studies, and usually dismisses scientific evidence that is supported by Biblical findings. For instance, the earth is dated at millions of years old because of carbon dating,

> but rocks produced from volcanic eruptions, new rock, has also been carbon dated as older than the actual formation. Hence, there may be flaws with some scientific methods that have been generally accepted as truth.

Not everyone who argued that science supports the inclusion of alternative perspectives indicated they supported these alternative perspectives. Respondent 113 offers such a view related to the nature of the scientific method:

> 113: It gives an opportunity for all sides of science to be explored and tested. The Scientific Method can be used: systematic observation, measurement, and experiment, and the formulation, testing, and modification of hypotheses. This allows for the truth to be displayed whether is supports the current scientific theory.

The remaining individuals within the lens of education offered arguments which were oriented towards their view of science education. This indicated a concern for classroom practices, while directly addressing the scientific validity of the topics. Respondent 176 worried that such legislation “would totally confuse a middle school student.” At the same time, 14 did not like to “interject (his/her) personal opinion.” Others, like 34 and 148, felt preparation for college was important in the decision to address SSI in the classroom, but these two educators reached different conclusions. Respondent 34 was against the proposed legislation, believing science should focus on “STEM careers;” participant148 believed the bill should be passed and alternative topics included because “students should be introduced to controversial topics before they go to college.” Overall, 66.7% of those whose opinions focused on their personal views of science education supported the proposed legislation.

Table 111

Viewpoints within the Lens of Education

	Frequency	Percent
Promote Critical Thinking	35	40.7%
Personal View of Science Education	18	20.9%
Scientific Supports	33	38.4%

Table 112

Support for Legislation within the Lens of Education

	Support for Legislation	
	Frequency	Percent
Promote Critical Thinking	34	97.1%
View of Science Education	12	66.7%
Scientific Supports	8	24.2%

The findings presented in Table 113 show the relationship between the three categories within the lens of education and scores collected in this study. The three scores examined were overall score, perspective score, and reasoning quality. Those using a critical-thinking perspective had the highest overall score, indicating the highest support for the overall inclusion of SSI. This group had the lowest support for perspective. The score was .91 indicating some preference for aspects of science, but this score was some 9.30 points lower than those who provided arguments based on science evidence. Reasoning quality was also the highest for those employing science-based reasoning. Separate ANOVA tests confirmed a significant result for overall score

(p=.021), perspective score (p=.002), and reasoning quality (p=.041). Post-hoc analyses for these tests can be seen in Table 114.

Table 113

Views of SSI within the Lens of Education

		Critical Thinking	View of Science Ed	Science Supports
Overall score	N	33	18	28
	Mean	67.5	61.2	63.6
	Standard Deviation	8.22	6.39	8.15
	Significance	*F*(2, 76)= 4.08, *p*= .021.		
Perspective score	N	33	18	28
	Mean	.91	3.67	10.2
	Standard Deviation	7.93	9.21	12.0
	Significance	*F*(2, 76)= 6.95, *p*= .002.		
Reasoning quality	N	35	18	33
	Mean	5.34	5.50	6.64
	Standard Deviation	2.14	2.28	2.18
	Significance	*F*(2, 83)= 3.31, *p*=.041.		

Table 114

Post-Hoc Tests to Explain Significance in Scores for Those Using Lens of Education

	Group 1	Group 2	*p* value LSD	*p* value Scheffe
Overall Score	Critical Thinking	View of Sci Ed	.008	.029
Perspective Score	Scientific Supports	Critical Thinking	.000	.002
		View of Sci Ed	.031	.095
Reasoning Quality	Scientific Supports	Critical Thinking	.017	.056

Science Lens

Thirty-six or 31.6% of respondents used a science lens in their responses to open-ended questions (see Table 115). These responses were found to focus on the science supporting SSI in the classroom. The lack of focus on educational practices distinguished this lens from science education. Most of the time (61.1%) science and education lenses were found together. The argument from Respondent 209 illustrates the science argument. This response does not directly mention education; instead, the focus was scientific in nature.

> 209: This type of argument suggests a "scientific controversy" where none exists, utilizing words such as "theory" which have one meaning in common vernacular and another in scientific language to obfuscate and confuse issues which are at consensus with a significant portion of the scientific community.

Table 115

Use of Science Lens in Decision Making

	Frequency	Percent
Used Science Lens	36	31.6%
Didn't Use Science Lens	78	68.4%

The following argument from Participant 259 offers a slightly different perspective. This argument provides an assertion that science should focus on "science" and "evidence," but the view was based on practices within the classroom. This response was scored as representative of both science and education.

> 259: That teaching science should teach science, based on evidence. If students are to be taught about subjects for which there is no evidence, then those beliefs

and faith should be taught at home by their families - they are not science.

Science is without bias.

Statistical analyses were done to compare the views of those displaying a science lens versus those using another lens. As seen in Table 116, overall score and perspective score were not significantly different (*p*= .522 and *p*= .142). Reasoning score was higher among those who invoked a science lens (*p*=.003). It was found that not all respondents within this category were in opposition to the proposed legislation. One-half (50.0%) of the respondents said they would support bills like Tennessee House Bill 368 (see Table 117).

Table 116

Scores Separated by Use of Science Lens in Decision Making

		Science	Other
Overall score	N	31	70
	Mean	63.4	64.5
	Standard Deviation	6.79	8.38
	Significance	*t*(99)= -.642, *p*=.522, *ns.*	
Perspective score	N	31	70
	Mean	7.52	4.20
	Standard Deviation	13.1	8.96
	Significance	*t*(99)= 1.48, *p*=.142, *ns.*	
Reasoning Quality	N	36	78
	Mean	6.44	5.09
	Standard Deviation	2.29	2.13
	Significance	*t*(112)= 3.09, *p*=.003.	

Table 117

Support for Legislation among Those Using Science Lens in Decision Making

	Support for Legislation	
	Frequency	Percent
Used Science Lens	18	50.0%
Used only other lenses	45	57.7%

To better understand this split, responses were further evaluated to find variations. It was found that exactly 50% of those using a science lens did so to argue that science supports the inclusion of alternative perspectives (see Table 118).

Table 118

Viewpoints within the Lens of Science

	Frequency	Percent
Science supports traditional scientific view	18	50.0%
Science supports inclusion of alternatives	18	50.0

Arguments under the science lens may have described science as being in support of one traditional view and were often listed in both science and education lenses. Individual 34 offers one such response. Similar to the situation mentioned in the education lens earlier, not all of those using a science lens argued that only one perspective is supported. Respondent 253 provided one such response.

> 34: Science should not be politicized. Science is based on testable hypothesis and theories are more than conjectures. Science should be based on empirical evidence.

253: Teachers need scientific proof. I listened to a certified scientist for three nights who totally convinced me of the New Earth/Creation Theory as opposed to the theory of evolution. Watch the documentary movie "Expelled." Scientists from around the world were giving pros and cons. Very convincing.

Table 119 shows the percentage of those individuals who supported the proposed legislation. These numbers were 0 for those who believed that science supports only the traditional science view, and all 18 of those who believed science could be used to argue for the inclusion of alternative ideas supported the previously discussed legislation.

Table 119

Support for Legislation among Those Using Empirical Evidence to Support Decision Making

	Support for Legislation	
	Frequency	Percent
Science supports traditional scientific view	0	0.0%
Science supports inclusion of alternatives	18	100.0%

Table 120 shows the differences that were seen when the overall score and perspective score were examined among those employing these diverging views of science. Those using the science lens were less likely to support the inclusion of all SSI in the curriculum (p=.002), but were more likely to support the science perspective (p<.001). Reasoning did not show a significant variation (p=.389).

Table 120

Views of SSI within the Lens of Science

		Science	Alternatives
Overall score	N	14	17
	Mean	59.4	66.7
	Standard Deviation	6.71	4.97
	Significance	*t*(29) = 3.44, *p*=.002.	
Perspective score	N	14	17
	Mean	17.7	-.880
	Standard Deviation	10.6	7.98
	Significance	*t*(29)= -5.57, *p*< .001.	
Reasoning Quality	N	18	18
	Mean	6.78	6.11
	Standard Deviation	2.29	2.30
	Significance	*t*(34)= -.872, *p*=.389, *ns*.	

Religious Lens

A religious or social lens was used by a number of participants when developing arguments for or against bills like the one from the Tennessee legislature. These frequencies and percentages can be seen in Table 121. Those employing this lens made statements that included references to social or religious institutions. Responses from participants 9 and 12 reveal two references to religion from opposing perspectives.

> 12: My fear is that if we don't have this type of legislation in the South, particularly, we will have teachers who only teach the more religious, traditional

beliefs and will not fully cover the more scientifically proven areas including evolution and climatology.

9: You cannot assume that all people have the same religious and cultural beliefs so all should be addressed.

Table 121

Use of Religious/Social Lens in Decision Making

	Frequency	Percent
Used Religious/Social Lens	28	24.6%
Didn't Use this Lens	86	75.4%

As illustrated by the quotes above, a reference to religion was not tantamount to an endorsement of the discussed legislation. As shown in Table 122, only 39.3% of those using a religious or social lens would support such legislation. Statistical analysis did not support the existence of a significant relationship between the use of a religious lens and any of the views measured in this study. These data can be seen in greater detail in Table 123.

Table 122

Support for Legislation among Those Choosing Religion/Social Factors in Decision Making

	Support for Legislation	
	Frequency	Percent
Used Religious Lens	11	39.3%
Didn't Use	52	60.5%

Table 123

Scores Separated by Religious/Social Lens for Decision Making

		Religion/Social	Other
Overall score	N	24	77
	Mean	63.2	64.5
	Standard Deviation	6.45	8.32
	Significance	*t*(99)= -.695, *p*=.489, *ns.*	
Perspective score	N	24	77
	Mean	5.08	5.26
	Standard Deviation	11.2	10.3
	Significance	*t*(99)= -.072, *p*= .943, *ns.*	
Reasoning Quality	N	28	86
	Mean	6.04	5.35
	Standard Deviation	1.99	2.33
	Significance	*t*(112)= 1.40, *p*=.163, *ns.*	

Further analysis was used to explain this lack of correlation between the use of a religious or social lens and views of SSI. Four separate viewpoints were found among those employing a religious lens. One of these groups based their view on religious beliefs. Participant 7, for example, simply described her argument as “Biblical.” Respondent 41 said, “I would use arguments based on my faith in a divine creator or intelligent designer.” Participants 7 supported the legislation while 41 did not. In the examination of all responses it remains unclear why number 41 would not support the legislation.

Another group of participants argued for the protection of religious/social institutions. This included the protection of views among students. Participant 73 provided an example argument using this lens:

> 73: I believe that most students in my classroom have a Christian view on life. There [are] always two sides to every story and this is no different. All people have their own opinion and ideas about these scientific subjects.

A larger group of respondents (11) gave responses which used a religious lens, but did so from a viewpoint intended to protect individuals from religious institutions. Those using this lens were not typically hostile towards religion, but emphasized the differences between religion and science.

> 194: I feel that the role of education is to present scientifically accepted facts. As I do not expect churches to present evolution as an option, I do not feel that it is fair to force schools to present creationism.

Two individuals who did not support the proposed legislation cited the separation of church and state as a supporting criterion for their opinion. One of these participants, number 22, succinctly wrote, “I think that passing this type of legislation can strain the position of separation of church and state.”

Table 124 shows the percentage within the religion/social institution lens that used each of the aforementioned frameworks. Table 125 illustrates the imperfect relationship between the selected lens and support for the legislation. The selected framework was a fairly good indicator of opinion for all of the viewpoints, except among those who based their arguments on religious views.

Table 124

Viewpoints within the Lens of Religion/Social Concerns

	Frequency	Percent
Opinion based on beliefs	10	35.7%
Protect Institutions	5	17.9%
Protect people from institutions	11	39.3%
Separation of church and state	2	7.1%

Table 125

Support for Legislation among Those Using Religious/Social Factors to Make Decisions

	Support for Legislation	
	Frequency	Percent
Opinion based on beliefs	5	50.0%
Protect Institutions	4	80.0%
Protect people from institutions	2	18.2%
Separation of church and state	0	0.0%

To further analyze results, those within this lens were seperated by those with a view supporting religious or social factors and those with a perspective in opposition to the influence of these ideas. As seen in Table 126, the differences between these groups were only shown to be significant for perspective score. Those in the opposition category supported the scientific perspective in larger percentages than those in the opposing group.

Table 126

Views of SSI within the Religious/Social Lens

		Support Religion/social factors	Oppose Religious/social factors
Overall score	N	15	9
	Mean	62.6	64.1
	Standard Deviation	6.84	5.99
	Significance	$t(22)$= -.548, p=.590, *ns.*	
Perspective score	N	15	9
	Mean	.200	13.2
	Standard Deviation	9.90	8.32
	Significance	$t(22)$= -3.30, p= .003.	
Reasoning Quality	N	15	13
	Mean	5.53	6.62
	Standard Deviation	2.77	2.14
	Significance	$t(26)$= -1.47, p=.155, *ns.*	

Other Lenses

Three other lenses were identified, but were observed infrequently. A total of 19 responses were seen to represent aspects of other lenses. The frequency of each response within this category can be seen in Table 127. Of the 19 responses only three came from individuals who indicated they would support SSI legislation similar to the bill outlined in the assessment. More specific levels of support can be seen in Table 128.

Table 127

Viewpoints within the "Other" Lens

	Frequency
Legislative/Political	10
Unnecessary	4
Logistic	5

Table 128

Support for Legislation among Those using Different Viewpoints within the Governmental Lens

	Support for Legislation	
	Frequency	Percent
Legislative/Political	1	10.0%
Unnecessary	0	0.0%
Logistic	2	40.0%

The first and most frequently observed lens for decision making within this category was legislative or political concerns. Responses given this designation referred to the role of government or specific aspects of the proposed legislation. The most frequent responses included concerns over government interference. Others were against the politicization of educational topics. Participant 251 simply wrote, "I don't believe the government should interfere." Individual 264 gave a similar, but seemingly more emotional response:

> 264: I would tell them to "get ready" because this is just the first in a long line of bills we will have to pass so to ensure all teachers say everything exactly right to every student.

Another group or respondents believed the legislation was unnecessary. These responses did not indicate a personal view of the legislation. In some instances there was a perception that what the bill covers is already protected in the classroom. Respondent 180 simply believed such legislation to be “unneeded.” Another educator, Participant 90, believed teachers already had the freedom offered by the discussed bill:

> 90: Educators already have the leeway needed to make a balanced presentation of theory.

The final group identified expressed practical concerns over the implementation of such a curriculum in the classroom. Participant 74 said he or she would not support the bill until reviewing “further documentation.” Others believed teachers needed more training before putting such a curriculum in practice. Respondent 256 simply believed it would not matter in the classroom.

CHAPTER V

DISCUSSION

The following discussion summarizes and emphasizes the most important findings of my study. This includes a comparison of my results with previous studies having a similar focus. The discussion begins with an overall summary of the views participants hold concerning SSI in the classroom, followed by an analysis of these findings in light of potentially important demographics and the teaching positions of the respondents. This is followed by an examination of views of evidence and those factors that were most important for decision making. Next, the open-ended results are analyzed emphasizing participants' views of SSI legislation, the demonstrated reasoning quality, and the lenses employed by educators when making decision concerning SSI. The discussion concludes with a summary of the most important findings and the potential implications of these results.

Overall View of SSI in the Curriculum

Teachers are willing to embrace socioscientific issues in the classroom. This number was as high as 89.0% for the all educators in this study, but this support was not necessarily an indication of support for a scientifically substantiated view. The highest levels of support were found when opposing perspectives were included in the curriculum. These opposing views included ideas that are commonly supported by scientists and those that are not. Intelligent design is almost certainly the most prominent alternative view, which is often included in classroom instruction, but finds little support from empirical science. Continuing with this example, 55.9% of educators in this study were in support of the inclusion of alternatives to evolution, with an additional 16.6%

undecided. While most (62.6%) of the educators give preference to science-supported ideas, this support is not universal and is not uniform. The greatest support for scientific evidence is found for climate change topics; evolution and stem cell research are much more fiercely contested. The remainder of this discussion will examine the findings reported in the previous chapter in an attempt to illuminate the different opinions of SSI held by educators.

Polling has found a growing number in support of the inclusion of alternatives to evolution (Berkman & Plutzer, 2010). Science educators have been successful at maintaining evolution as an official part of the curriculum, but much less successful in convincing teachers to support its inclusion (Berkman et al., 2008). I found most educators (61.6%) were willing to accept evolutionary ideas into the curriculum. This was true when the measure included both science-supported ideas and those alternative ideas like intelligent design. When these ideas were separated the results became less decisive. The number in support of evolution was higher than the number who preferred alternative perspectives, but these groups were separated by only 3.4%. Over a third, 37.4%, preferred the inclusion of science-supported views of evolution and 34.0% had greater support for alternative views. This left 28.6% who were undecided. The results seem to lend credence to the view that the inclusion of SSI is an unsettled matter.

Federal commissions have called for an increased focus on certain ethical discussions within the science classroom (Presidential Commission for the Study of Bioethical Issues, 2010). These views could have a direct impact on the role stem cell research plays in science instruction, but those science educators charged with the implementation of the curricula are uneasy with the prospect of including ethical discussions within such courses (Hodson, 2003; McGinnis & Simmons, 1999; Sadler et al., 2006). I found a large number (69.7%) supported the inclusion of ethical discussion related to stem cell research. This was only true when both the rights of embryos and the potential benefits of stem cell research were included equally. When those views were separated, 35.3% were found to support stem cell research over the protection of embryos. The largest group, which included 49.8% of respondents, had a view without preference for either side, with 15.0% remaining undecided.

Polling has suggested that acceptance of climate change is an unsettled matter in the United States, and levels of acceptance are dwindling (Pew Research Center, 2009). I found an overall willingness to support the inclusion of climate change in schools. A somewhat surprising 89.4% of educators felt the topic should be included. Once again, this number includes ideas that support the existence of climate change and ideas that oppose climate change. When these opposing views were compared, 66.8% had a preference for aspects of science-supported climate change. Most of the remaining individuals (26.6%) had a neutral perspective. Unlike evolution and stem cell research, opinions of climate change seem to be less ethical in nature, a view which is supported in Levinson's criteria of what constitutes a reasonable disagreement (Levinson, 2006a). For all topics certain personal views were consistently associated with certain views of socioscientific issues.

Multiple science education groups have worked to encourage the inclusion of scientifically supported materials within the school curriculum (American Association for the Advancement of Science, 1989; National Academy of Sciences, 1999; National Science Teachers Association, 1996). While seemingly obvious, this has not always been a popular position. Battles over evolution have been the most visible, but other fights have emerged as science has advanced. I found the majority of educators willing to include SSI in curriculum, but this number was not constant and the inclusion of a topic was not necessarily indicative of support for a science-based perspective. A few important factors were associated with those who held a view emphasizing the inclusion of alternative perspectives. I will spend the remainder of this work attempting to describe those important factors, which are associated with certain beliefs. I place special value on the beliefs associated with educators, specifically educators in certain teaching positions. It is clear a secondary science teacher will have more of an impact on SSI instruction; thus, much of the focus explores educators separated by teaching position.

View of SSI separated By Demographics

Many opinion polls commonly include certain demographic information when measuring views of science topics. I chose to include population, religious views, church attendance, political party, and political ideology in my exploration of the views held by educators. Most of the respondents were from rural areas and were Christian. Political party and ideology were more evenly divided. All of these factors have been shown by previous polling to be correlated with views related to one or more socioscientific issue.

Variations in mean scores for overall view of the inclusion of SSI were significant only for aspects of climate change. This means that when negative and positive views of science were compiled to calculate an overall willingness to include SSI in the curriculum no variation was seen for any factor other than climate change. Furthermore, in each instance the educators surveyed were willing to include the SSI overall when both views were included.

Those in the rural category did prefer the perspective in support of evolution, but this support was significantly less than their urban counterparts. The religious affiliation of participants was separated into Evangelical and others. Both were more willing to include pro-science aspects, but the number for Evangelicals was close to zero and significantly lower than the same measure for non-Evangelical groups. The same result was seen among those who attend church services more often. Political party was another indicator of SSI perspective. Republicans had a perception that preferred alternatives to science-supported ideas. Both Democrats and Independents had scores indicating support for science perspectives and were significantly higher than their Republican counterparts. When political views were isolated to conservatives the results became more negative. This result was significantly lower than other political ideologies. In short, those in all categories, except climate change, were willing to accept SSI in the curriculum when "both" sides were included. Republicans, conservatives, Evangelicals, frequent church attendees, and those from rural areas were all less accepting of science-based perspectives. These findings will be separated by specific topic in the remainder of this section.

Views of Evolution among Various Demographic Groups

Most scientists view alternatives to evolution as religious based (Berkman et al., 2008). This view is supported by numerous studies tying views of evolution to certain religious beliefs. Those who attend church regularly have been shown to be less supportive of evolutionary ideas (Newport, 2009). This was especially true for those who attend certain types of religious services, including those belonging to Evangelical Christian denominations (Masci, 2009). Variations in views are not limited only to certain religious beliefs; the overall views of the local community are reflected in the classroom. For multiple reasons, a teacher is less likely to include evolution in the classroom in those geographical areas where evolution is not supported (Berkman & Plutzer, 2010).

All demographic groups in this survey were willing to accept evolution into the curriculum if ideas in opposition and ideas in support were both included. The same perspective was not shared by all groups. Those from rural areas had a perspective in support of those ideas which run counter to scientifically supported views of evolution, while the urban group was firmly in support of evolution and significantly different than those from rural areas. Evangelical groups had a preference similar to the views of urban educators. It is likely that a notable overlap exists between rural and Evangelical populations. Those with other religious affiliations did not have a similar bent in opposition to the inclusion of science-based evolutionary principles. Similar to prior studies (Newport, 2009), I found those educators who attended religious services most often to be more receptive of the inclusion of evolution alternatives.

While the overall inclusion of evolution did not vary, the highlighted perspective was different when respondents were separated by political views. Educators identifying with the Democratic and Independent parties supported the inclusion of pro-evolution ideas over alternatives to these principles. This was not true for Republicans, nor was it true for conservatives. Many of those with conservative views were Republican, but the relationship was not totally uniform, and support for evolution was greater among the conservative group.

Views of Stem Cell Research among Various Demographic Groups

Similar to evolution, when ideas supporting of stem cell research or emphasizing the rights of embryos were included all demographic groups showed support for inclusion of the topic and differences were not significant. Those in rural areas did have a significantly lower perspective score. The score was positive, indicating some preference for stressing the benefits of research; the number was significantly lower than for those in urban areas.

In an attempt to circumvent the ethical concerns of embryonic stem cell research, researchers have developed certain medical techniques (Denker, 2009). Others believe that this is only delaying an ethical discourse which needs to occur, and ultimately views of stem cell research vary with one's view of human life (Holm, 2008). Evangelicals held a view that was only slightly more supportive of research than the protection of embryos. Other religious groups showed significantly higher levels of support for the practice. Those who attended religious services the most often had a slightly positive perspective for stem cell research topics, but these numbers were significantly different than for less frequent church attendees. My findings for Evangelicals and regular church attendees support prior research, which found a similar lack of support among some religious groups, including Evangelical Christians (Masci, 2008).

The Catholic Church, which has vehemently opposed embryonic stem cell research as an abhorrent practice, recently announced unequivocal support for adult stem cell research (Myers, 2012). Due to the opposition to embryonic stem cell research espoused by their church, Catholics were isolated and compared with other groups. Catholics in my study were found to be more supportive of stem cell research than the group as a whole. The high support for SCR among Catholics was a somewhat unexpected finding.

Views of stem cell research have been tied to certain political positions. This can be illustrated by examining the conflicting executive orders issued by the current and previous presidents (Kingston, 2001). Prior studies found Democrats and Independents more likely to support research over the rights of the embryo (Masci, 2008). My findings support this view. Republicans had a view which slightly preferred highlighting the rights of embryos in the classroom, a view which was significantly different when compared with those in other political parties. This same trend was seen when conservatives were compared with non-conservative educators.

Views of Climate Change among Various Demographic Groups

Like stem cell research, climate change has become a topic of political interest. Current proposals, such as “cap-and-trade,” have become partisan issues of debate. Independents and especially Democrats have been shown to be more receptive to climate change ideas (Pew Research Center, 2009). For climate change all demographic factors, except political ideology, followed the previously described pattern. They each showed support for the topic when both supportive and alternative views were included. When the views were separated there was not a significant difference between the view of rural educators and urban educators. Each was somewhat supportive of including the ideas that climate change is occurring, human pollution is a part of the problem, and something can be done to stop it.

Climate change was the only SSI that did not show significant variation based on religious affiliations. All religious groups were supportive of the inclusion of ideas in support of climate change over the opposite approach, and any differences present were not statistically significant. For those who attended church weekly or more, numbers indicated support for pro-climate change in the curriculum, but in numbers significantly lower than for less frequent church attendees. Republicans showed some support for the inclusion of pro-climate change ideas, but the results of this group were significantly lower than results for Democrats and Independents. Among those describing themselves as conservative a positive view for the inclusion of climate change was seen. This was the only demographic factor that showed significant variation in the overall view, with the conservative group having a lower willingness to accept this topic. The perspective trend held true to what was expected, with conservatives having a positive, but significantly lower view for the inclusion of ideas in support of climate change.

Representations of Content Knowledge and view of SSI

Content knowledge almost certainly plays some role in the views held by individuals (Lewis & Leach, 2006). Based on this idea certain trends have emerged. For example, those with greater content knowledge are more likely to have a positive view of science topics (Topcu, 2010), and those with high school educations or less are not as likely to support evolution (Newport, 2009). Some evidence exists to explain general trends, but a direct explanation of the relationship between content knowledge and views of science remains uncertain. Researchers have proposed that this relationship is difficult to interpret because it is ultimately a question how knowledge is transferred and applied (Wynne, Stewart, & Passmore, 2001). Understanding knowledge transfer regarding SSI is likely to include an exploration of ethical and/or moral perspectives.

A survey to measure content knowledge was not included in my study. Instead, participants were asked to list the number and type of science courses they had taken while in college. Prior research has shown the number of science classes taken to be an indicator of how certain science topics will be covered in the classroom (Berkman et al., 2008). Respondents were divided into low, medium, and high categories based on the number of science course they had taken while in college.

For the educators I surveyed the number of science courses taken was not an indication of view for overall inclusion of SSI for any of the selected topics. Those who took a greater number of science courses did have a more positive perception of science-supported topics. For evolution and stem cell research those in the lowest group had views which preferred alternative views to the scientific perspective. The middle group was not negative for any SSI, but scores for both the low group and the middle group were significantly lower than scores for those with more college science hours.

As a second measure of content knowledge educators were asked to describe their own understanding of SSI content. Those with “above average” or “excellent” understanding of the topics showed no significant variation in overall willingness to include SSI in the curriculum. The differences in perspective were significant for two of the three SSI. Those who self-reported a lesser understanding of evolution showed a perception that preferred alternatives to evolutionary science. This number was not, however, significantly lower than their colleagues who reported a greater understanding. Both groups showed a preference for the research perspective and for climate change. The view of SCR in the curriculum was more positive for the group reporting the lower understanding; these positions were reversed for views of climate change.

The group with 12 or more college science courses represented 36.2% of the responding teacher group, leaving 63.8% of participants in the lower two categories. The numbers did not match self-described understanding. Over half (50.5%) listed their understanding of evolution as “above average” or “excellent.” Far fewer educators (27.3%) described their understanding of SCR in one of these higher categories. For climate change the percentage of those placing their understanding in one of the two categories above average was 33.8%.

Prior studies have found understanding of the topic may not be the most important factor in decision making for some topics (Bell & Lederman, 2003; Lee, 2007). In these instances ethical concerns may be better indicators of view than understanding of the content (Bryce & Gray, 2004; Ratcliffe & Grace, 2003). Some individuals are likely to separate understanding of content from decision making (Zeidler et al., 2002). The results of my study do not support this conclusion, but also do little to refute the prior findings. These results do lend a modest level of support to the Threshold Model of Knowledge Transfer proposed by Sadler and Donnelly (2006). Those in the lower two categories for number of science courses had a consistently less positive view of the inclusion of science topics compared with alternative views.

Views of SSI in the Curriculum Separated by Teaching Position

Classroom practices have the most important impact on science literacy, and some 90% of classroom practices related to SSI are based on the personal views of educators (Berkman et al., 2008). With this in mind, much of the analysis conducted for this study focused on the views of educators separated by teaching assignment. Prior studies have found some severe misconceptions exist among teachers. For example, 16% of high school biology teachers believe the earth is less than 10,000 years old and humans were placed on the planet in their current form (Berkman et al., 2008). While this number is noteworthy, it is much lower than the general population where 48% oppose the basic ideas of evolutionary theory (Plutzer & Berkman, 2008). Views of educators are likely reflected in classroom practices. Studies have shown that evolution is the only view covered in approximately 60% of classrooms (Moore, Brooks, & Cotner, 2011), leaving the remaining classes divided primarily among those that include multiple views of evolution and those that cover neither topic. Three percent of students in one study said their high school science course only discussed creationism (Moore et al., 2011).

I divided participants into seven groups according to their teaching positions. The classifications of elementary, middle, and high school teacher were used, with each previous category further divided into those who teach science and those who do not. A seventh category was used for those employed in some other manner within education. This group was given the title “administration.”

Scores for the overall inclusion of SSI in the curriculum were significantly different among the seven categories used to describe teaching position. All of the groups supported the inclusion of SSI to some degree, but secondary non-science teachers had a higher score than any of their counterparts. Elementary science teachers had an especially low level of support for the inclusion of SSI overall. As shown by post-hoc tests, at least one of these three groups was involved in each significant reaction.

Preference for what should be included in the curriculum also varied significantly between teaching groups. Scores were lowest among the two elementary teacher groups. These were the only two positions where preferences supported perspectives alternative to science. High school non-science teachers were the next lowest group, while secondary science teachers had the highest perspective score. Thirteen of the 21 total interactions for perspective were shown by post-hoc tests to be significant. Each significant interaction included at least one of the five previously mentioned extreme groups.

Overall views for the inclusion of evolution were significantly different between groups. Noticeably lower scores were seen among elementary teachers. Post-hoc tests confirmed that elementary teachers were involved in each of the significant interactions among the seven groups. Perspective scores for evolution were also found to vary significantly between groups. Scores indicating a preference for alternatives to evolution were seen for both elementary school groups and for high school teachers who do not teach science. Middle and high school science teachers had a perspective that was most supportive of science-based evolutionary ideas. The differences in evolution scores were significant for most of the possible interactions (17 of 21).

An additional analysis was conducted after questions indicating support for evolution were separated from those measuring alternative ideas. Elementary school teachers did not support the inclusion of scientifically-backed views concerning evolution. These same groups did support the inclusion of alternative ideas. All of the remaining groups did support the inclusion of topics that maintain the scientific view of evolution. High school science teachers did not support the inclusion of evolution alternatives and had the lowest score. Middle school science teachers and those in the administration category also did not support the inclusion of those ideas opposing evolution.

Views for the inclusion of SCR were found to vary significantly. The lowest level of support was found within the elementary science group. This was the only group that did not support the overall inclusion of SCR. The next lowest scores were among those elementary school teachers who did not teach science and middle school teachers who did teach science. The highest supports for inclusion were found among secondary non-science teachers. Preference for what should be taught also varied with teaching position. Elementary school teachers and high school non-science teachers had a preference for a curriculum emphasizing the rights of embryos over medical research. The highest support for research in the curriculum was seen among high school science teachers and administrators, followed by middle school science teachers.

Elementary school science teachers were the only group that did not support the inclusion of pro-stem cell research ideas in science curriculum. Elementary school teachers who did not teach science had the second lowest level of support for pro-research ideas. High school science teachers had the highest support for these views. Elementary school science teachers did support pro-embryo ideas, but this number represented the second lowest score among the groups. Science teachers at all levels had the lowest support for those topics supporting the rights of embryos. The highest level of support was found among high school teachers who did not teach science.

Support for the inclusion of climate change was higher than for the other two SSI. Climate change was the only topic in which support for the overall inclusion did not change significantly between teaching groups. Perspective scores were significantly different, but this was the only topic in which all values were positive. No group was found to prefer the inclusion of those ideas which oppose the existence of climate change.

The highest support for the overall inclusion of pro-climate change ideas and opposing views was found among secondary science teachers; lowest scores for this measure were seen within high school non-science teachers. When pro-climate change and anti-climate change ideas were separated the significance was found to lie within the inclusion of those ideas opposing climate change. Secondary science teachers had a lower acceptance of anti-climate change ideas compared with their colleagues who did not teach science.

Table 129 summarizes the previously discussed results regarding view of SSI in the curriculum. From the overall score a few trends emerge. Middle school and high school teachers who do not teach science were the most receptive of an overall inclusion of multiple aspects of all SSI. Elementary school teachers held a view that was generally the least receptive for the overall inclusion of SSI. For perspective score more clear trends emerged. Elementary school teachers, science and non-science, were consistently the least supportive of the scientific perspective. These groups were closely followed by high school non-science teachers. For each topic middle school non-science teachers were ranked fourth in terms of perception of science ideas. The most receptive of science ideas were consistently secondary science teachers and administrators.

Table 129

Ranked View of SSI in the Curriculum Separated by Teacher Group

		Elem, Non	Elem, Sci	Mid, Non	Mid, Sci	High, Non	High, Sci	Admin
Overall Score- 1 to 7 most receptive to least receptive of SSI in the curriculum	Total	6	7	2	4	1	3	5
	Evolution	7	6	1	3	2	4	5
	SCR	4	7	2	6	1	3	5
	Climate*	4	6	2	7	1	3	5
Perspective Score- 1 to 7 most receptive to least receptive of science supported ideas	Total	6	7	4	2	5	1	3
	Evolution	6	7	4	2	5	1	3
	SCR	6	7	4	3	5	2	1
	Climate	6	4 (tie)	4 (tie)	1	7	2	3

*The only result that was not significant

Views of Science/Scientific Evidence

Groups like the Intergovernmental Panel on Climate Change (IPCC) have concluded that climate change is occurring, that it is a significant problem, and that humans are responsible (IPCC, 2007). Similarly definitive statements have been made regarding evolution and climate change, yet all three topics remain unsettled among the broader population. Once a conclusion has been reached it becomes unlikely an appeal to evidence can be made which will convince those in opposition to change their perspective. Appeals to evidence are often unlikely to persuade individuals to alter their views (Filho, 2009). In some instances it has been shown that individuals will disregard convincing evidence simply because it conflicts with previously held opinions (Sadler et al., 2004). Considering the prior conclusions from the IPCC views of evidence are likely reflections of overall opinion on the specific science topic.

Views of Evolution as a Science

Less than half (46.4%) of the educators surveyed were willing to describe evolution as a “credible field of science.” Of the remaining 53.6%, the majority (28.3%) opposed this view with nearly as many (25.4%) in the undecided category. Only a third of educators (33.0%) found the evidence supporting evolution to be “accurate and unbiased.” A somewhat surprising 38.7% were willing to say they disagreed with the idea that credible evidence exists to support evolution. These numbers are comparable to a larger study by another researcher, which examined the views of the broader public and found 39% in support of evolution and 36% remaining undecided (Newport, 2009).

When views of evolution as a science were divided among teaching groups the greatest opposition to the idea that evolution is a “credible field of science” was seen among elementary teachers and high school teachers who do not teach science. These three groups were also the only three groups that had negative perspective scores for evolution. Conversely, the highest levels of support for evolutionary science were seen among secondary science teachers. Middle school and high school science teachers were found to be most supportive of pro-evolution ideas in the science classroom.

Similar trends were found for the “unbiased and accurate” question. Those with the lowest perspective scores, elementary teachers and high school non-science teachers, were also those who most vehemently believed the evidence supporting evolution was not credible. Similarly, secondary science teachers were the most supportive of the inclusion of pro-evolution ideas in the classroom and were the most supportive of the evidence underlying evolution.

Views of SCR as a Science

Previous polls suggest that 62% of respondents believe embryonic stem cell research can be done in morally responsible manner (Gallup, 2010), yet the majority of Americans place the rights of embryos above the medical benefits that may be developed from the research (Fundacion BBVA, 2008). In somewhat similar numbers, the majority of educators in my study (58.7%) agreed the use of embryos in medical research could produce significant medical advances. Only 12.5% were willing to say they disagreed with this statement. Support for this idea did not translate to support for the use of embryos in research. A more modest 38.8% would support the use of embryos in medical research. Over a quarter of participants (28.7%) were willing to disagree with this use of embryos.

Those teacher groups with the greatest opposition to the use of embryos, elementary teachers and high school teachers who don't teach science, were also the three groups with negative perspective scores for SCR in the curriculum. Those with the greatest support for the use of embryos, administrators, secondary science, and middle school teachers who don't teach science, corresponded with higher perspective scores.

Results were somewhat less clear for the view that stem cell research could lead to medical advances. This is likely due to high level of support for this idea among teachers from all positions. Elementary educators did have a noticeably lower level of support for the previously stated idea. These were also the two groups with the lowest support for the inclusion of pro-embryonic research in the curriculum. Those in teaching positions who believed stem cell research offered significant possibilities corresponded with high perspective scores for all groups except high school non-science teachers. This is likely explained by the high inclusion score for those in the group. High school non-science teachers supported the inclusion of both pro-embryo and pro-research perspectives.

Views of Climate Change as a Science

Of the SSI included in this study climate change seems the most closely tied to views of evidence. The existence of climate change is becoming a settled matter. The areas where examinations of empirical evidence can produce a reasonable disagreement are contained to cost-benefit analysis; the benefit to future generations is uncertain, while the economic impact to the current generation is certain (Purdy, 2010) These opposing views conflict when the impact of climate change and the plausibility of solutions are considered (Merril & Schizer, 2010; Nordhaus, 2008; Purdy, 2010). For many this perspective is influenced by a view that climate change may be occurring, but it is not a severe problem (Young, 2011).

The conflict surrounding climate change is not, however, limited to those aspects that would be described as legitimate. Prior research polls have found only 57% of respondents willing to definitively support the science behind climate change, only 36% were willing to say humans were a major cause, and 35% were willing to describe climate change as a major problem (Pew Research Center, 2009). Higher levels of support have been found when the survey is isolated to teachers.

A study which attempted to limit responses to educators found an astounding 89% believed climate change was occurring (Johnson & Holtzer, 2011). The same study found that only 13% of the responding educators believed climate change to be the result of natural causes. While clearly lower than the previously mentioned levels, I found a high level of support (65.1%) for the science of climate change. Fifty-seven of the remaining 72 respondents did not commit to support or opposed the science of climate change. A less impressive 35.8% of all responding participants believe the evidence supporting climate change is "both accurate and unbiased." A smaller 26.5% of educators disagreed with this idea. The largest percentage of participating educators, 37.7%, would not commit to either view.

Illuminating the importance of teacher views, one study found 47% of educators teach both sides of climate change because they believe both sides are supported by science (Johnson & Holtzer, 2011). As with the previously discussed SSI, views of climate change and the evidence for climate change were separated by teaching position. Views of the science of climate change did not consistently vary for the overall views for the inclusion of climate change or the preferred perspective. The lack of insight for overall score is understandable given the recognition that scores did not vary significantly between groups. The highest support for climate change was seen among the group with the highest perspective score, middle school science teachers. Support for the evidence underlying climate change seemed to reveal some more recognizable trends. Secondary science teachers along with administrators had the highest support for climate change and the highest support for pro-climate change ideas in the curriculum. The lowest scores for both measures were found among elementary teachers and high school non-science teachers.

Reasoning and ultimately conclusions often correspond with preferred sources of information (Yang & Anderson, 2003). Those with a preference for the scientific perspective prefer scientific sources of information; those with a preference for alternative views prefer non-science based sources. For the topics presented here a scientific preference would likely correspond with support for science in the curriculum. It is possible, however, that support for scientific data is not the reason for a pro-science conclusion. Actual support for scientific evidence may be less important than other factors in reaching conclusions regarding certain topics (Zeidler et al., 2002). This is likely an unconscious process and for this study would be reflected as a stated position in support of or opposed to the science behind the highlighted topic. Studies in which participants were willing to take a position opposed to their view of the evidence examined the two variables independently. My study found views of evidence largely consistent with preferred perspective to be included in the science classroom.

Decision Making in the Classroom

Educators in this study most frequently listed scientists and teachers as ultimately responsible for making decisions concerning SSI in the classroom. Teachers were selected by more than half of participants as being primarily responsible for making decisions regarding the teaching of evolution, stem cell research, and climate change. Scientists surpassed teachers only for the topic of climate change. Parents were selected third most often for evolution and SCR; this was not true for climate change. This lends additional credence to the idea that evolution and SCR have a more significant moral component when compared to climate change.

School boards were the least selected for all three SSI. Interestingly, school boards have been the impetus behind many of the recent controversies calling for an increased focus on alternatives to science (*Kitzmiller v. Dover Area School District*, 2005). I also found little support for using a national curriculum to determine which aspects of controversial science topics should or should not be covered. It is almost certain that any groups responsible for developing a national curricula would be strong supporters of a pro-science perspective (American Association for the Advancement of Science, 1989; National Academy of Sciences, 1999; National Science Teachers Association, 1996).

Almost all participants (91.9%) listed academic sources among their most important influences in to reaching decisions. The use of academic sources was so frequent that it did not seem to provide any insight into the views of the individuals. Fewer educators (21.7%) listed religion among their primary influences. Those groups which selected religious influence most frequently, elementary teachers and high school non-science teachers, were also those who had the most negative views of scientific perspectives.

Support for SSI Legislation

Support for the proposed legislation emphasizing the inclusion of alternative science ideas in the classroom did not perfectly mimic the previously described results. The majority of participants (55.3%) would support legislation protecting the inclusion non-scientific ideas. Noticeably higher levels of support were seen among high school non-science and elementary non-science teachers. These were two of the three groups with negative or near negative perspective scores. The third group, elementary science teachers, had the second lowest level of support and the second highest percent opposed to the bill. High school science teachers and the administration group were two of the three groups having the most positive perception of science-supported ideas in the curriculum. These two groups had the highest and third highest level of opposition to the proposed legislation. The third group, middle school science teachers, was found among those with the highest level of support for SSI legislation.

Little difference was found in the overall view of SSI legislation between those who supported the legislation and those who opposed it. T-tests found any differences present were not statistically significant. A similar result was seen for perspective score. Thus, it seems support for legislation like that proposed was not a reliable indicator of the views individuals hold regarding SSI in the curriculum.

Reasoning Quality

Argumentation has been used to assess understanding of science topics (Sadler & Zeidler, 2005) and as a method for assessing informal reasoning (Means & Voss, 1996; Sadler, 2004, Wu & Tsai, 2007; Zohar & Nemet, 2002). Questions have been raised regarding the ability of students to produce quality arguments (Kuhn, 1991; Perkins et al., 1991). Jimenex-Aleixandre et al. (2000) found 66% of high school students produced arguments that lacked support, and no students produced an argument that included all aspects signifying a well-constructed argument. Similarly, only 40% of high school students were able to provide any arguments counter to their own personal positions (Wu & Tsai, 2007).

The previous studies dealt with high school students; therefore, a higher level of argumentation quality should be expected from the test population used for my study. The majority of educators (56.1%) in this study made a sensible argument in support of their own, but that argument was lacking some important detail. To be placed within this classification, respondents most often made a claim, but failed to substantiate that claim. The second largest group (37.7%) was able to state their position and provide supporting evidence or criteria. Most participants (50.8%) did not provide a valid claim in opposition to their own opinion. This measure was labeled as multiple perspective score and indicated a more advanced quality of reasoning. In some instances the respondent specifically stated he or she could not think of a valid argument. In other instances, the statement which was provided was merely a restatement of the individual's actual point of view. It is unclear if the individual simply did not understand the question, or if they were unable to provide a valid argument from an opposing perspective. A complete claim in opposition to their actual view with supporting detail was provided 18.4% of the time. The highest level of reasoning was given the moniker rebuttal score and was an indication of the participant's ability to provide a counter claim to an opposing perspective. A larger percentage (32.5%) was able to provide an argument, which included supporting criteria, attacking an opposing perspective. This number was possibly due to the fact that many claims began by alluding to the opposing perspective they were arguing against. A still high 40.4% of participants were unable or unwilling to provide an argument that countered an opposing perspective.

The mean overall reasoning quality score was 5.52. This score indicated that overall the respondents were able to make claims, but they did not support their claims. Only 10.5% of respondents were able to provide the highest reasoning quality for all three measures. Considering the impact of content knowledge, the same scores were analyzed with the number of college science courses serving as the independent variable. Reasoning quality was not significantly correlated with support for or opposition to the proposed legislation. Linear regression analysis found a similar result for overall view of SSI in the curriculum and perspective score. Reasoning quality was not an effective predictor of either. In addition, reasoning quality scores between teaching position groups were not significantly different.

It should be noted that argumentation quality may simply reflect the experiences one has with developing arguments (Sadler & Zeidler, 2004). Prior studies have found poor argumentation among those capable of producing higher quality responses (Means & Voss, 1996). It does seem, however, the results of this study reflect some important differences among participants. Few were willing to fully remove themselves from their own views and produce an argument from an opposing perspective. Only 18.4% of the time did respondents successfully supply an opposing claim with supporting details. Additionally only 10.5% of participants received the highest possible reasoning quality score. This poor reasoning quality seemed to be the result of an inability or an unwillingness to empathize with the opposing perspective. In some instances responses seemed to reflect a disdain or dismissal of those in opposition.

Decision-Making Lens

The same arguments used to assess reasoning quality were used to identify decision-making lenses among the educators surveyed. The decision making lens identified the perspective used by each educator to reach conclusions. These lenses were determined from prior literature and an examination of responses. Many of the educators in this study (41.3%) employed more than one lens in decision making. This was less than prior studies which had seen 70% of respondents using multiple lenses (Halverson et al., 2009). In these cases the participant was included in the analysis for both lenses. It is likely that this made drawing direct conclusions more difficult. The most frequently used lens, education, appeared with other lenses 40.4% of the time. When multiple lenses were used, education (19.3%) was paired most frequently with science. Other lenses were rarely seen together. For example, religion/social lenses were paired with science only 6.2% of the time. This was more than a prior study which found religious and scientific perspectives were never used together (Halverson et al., 2009).

Examination of all responses provided insights into the beliefs underlying decision-making lenses whether these lens appeared together or separately. The most frequently used lens was education. Views of education were involved in the decision-making process for 75.4% of participants. In the majority of responses (58.4%) only a single lens was observed. Further examination provides some insight into the previously described discrepancies.

When compared with the group as a whole, those using an educational lens did not have a significantly different view for the overall inclusion of SSI or the perspective of SSI which should be the focus of instruction. Reasoning quality among the group using an educational lens was higher than those groups using other lenses, and this difference was significant. As indicated by the perception and overall scores, educational lens was not a monolithic group. Three distinct modes of thought emerged within the educational lens.

The first of these modes emphasized a focus on critical reasoning skills within the classroom. Individuals within this group maintain that the ability to formulate independent conclusions is of primary importance for the science classroom and SSI instruction can be an important tool in accomplishing this goal. Those employing this mode of reasoning supported SSI legislation 97.1% of the time. Within the lens of education 38.4% of responses believed the science curriculum should be a reflection of scientifically supported ideas. Most of these (76.8%) would not support the proposed legislation. The remaining 24.2% believed science supports the inclusion of alternative ideas. Some felt the alternative perspectives are actually supported by empirical evidence, while others pointed to the scientific method as being inclusive of multiple views. The remaining group within the educational lens provided arguments focusing on a personal view of science education. These responses included arguments that addressed what was best for students and what should be the focus of science education. One-third (66.7%) of those within this category would support SSI legislation.

Overall scores, perspective scores, and reasoning quality all showed significant variations when an ANOVA was conducted using those within the three previously described categories within the educational lens. Those using a critical thinking perspective had the highest overall score and the lowest perspective score. I found the overall highest reasoning quality among those using science to support their reasoning.

The second most frequently observed lens was science, which was used by 31.6% of participants. The use of the scientific lens was not an indicator of overall view of SSI in the curriculum or perspective score. Those using a science lens did have a significantly higher reasoning quality, but this was not indicative of support for or opposition to SSI legislation. Exactly one-half of those using this lens would support the discussed legislation. This could be explained when arguments within the science lens were further analyzed. All of the respondents in this lens supporting the legislation believed science supports the inclusion of untraditional ideas. Individuals within this group held to the idea that empirical evidence can be used to support the inclusion of views which run counter to the generally accepted scientific opinion. The other half of this group all had a completely opposite view. These individuals found empirical evidence to support only the inclusion of a single perspective. Other ideas are based on a view that is not scientific in nature. Prior studies have found that approximately 25% of educators believe creationism to be supportable using scientific principles (Moore & Kraemer, 2005). In this study, I found 50.0% of those using the science lens and 15.8% of those overall to argue for the inclusion of SSI legislation on the basis that alternative ideas can be supported with science.

Nearly one quarter of educators (24.6%) argued from a religious or social perspective. No significant differences emerged when overall views of SSI, perspective scores, and reasoning quality among those using a religious lens were compared with those who used other decision-making frameworks. The use of religion in decision making was also not a direct indicator of support for the proposed legislation. The majority (60.7%) of those using this lens would not support legislation that protected alternative ideas in the science classroom. These results were explained upon further analysis of the arguments given by participants.

Legal battles have typically supported the teaching of scientifically backed aspects of evolution on the grounds that alternatives were based on religious belief (Berkman et al., 2008; *Epperson v. Arkansas*, 1968). State endorsements of religious-based views are prohibited by the establishment clause found in the First Amendment of the U.S. Constitution. Laws requiring disclaimers questioning the certainty of evolution (*Daniel v. Waters*, 1975) and laws requiring the teaching of creation along with evolution (*Edwards v. Aguillard*, 1987) have also been declared unconstitutional on the same grounds. Evolution and religion in schools have been so intertwined that a set of criteria referred to as the Lemon test have been established to help decide legal battles more quickly (*Lemon v. Kurtzman*, 1971). While a lack of support for religion has been seen in the courts, participants in this study were more willing to include religious views.

Those who used religion did not do so in the same manner; four different viewpoints emerged. One subset of the religious lens based their opinions on religious ideas. These individuals made decision based on a “biblical” perspective or “faith in a divine creator.” Basing views on religion was not an indication of support for SSI legislation. Only half of respondents in this framework would support the implementation of legislation protecting alternative views. Some of those opposed were not interested in the protection of scientific ideas. Instead, these individuals seemed to prefer the removal of the subject matter entirely.

Among the remaining 64.3% within the religious/social lens, the majority concerned themselves with religious or social institutions. Some of those remaining (5 out of 18) were concerned with protecting institutions or individuals from the potential influence of SSI. This includes those concerned with protecting the religious views of their students. Among this subset of the religious/social lens the majority (80%) would support the legislation. A larger number (11 of 18) were concerned with protecting students or classrooms from outside influence. This was not indicative of hostility towards religion, but was a view that science teaching should be separated from the impact of non-scientific institutions. Only 18.2% of those concerned with protection from religious or social institutions would support the proposed bill. Both of the two individuals in this lens opposed the discussed law on the ground it was a violation of the separation of church and state.

For analysis, the four viewpoints previously mentioned were divided into two categories: those supportive of religion/social factors and those opposed to religion/social factors. Overall view of SSI in the curriculum and reasoning quality showed no significant variation. Perspective score was significantly different with those on the opposition side having a higher score. Those relying on a lens that opposed the consideration of religious/social factors in making decisions had a greater preference for scientific ideas.

Nineteen responses included a lens which could not be placed in any of the previous lenses. Ten of these respondents expressed direct concern over the legislative process. This included the view that legislation addressing SSI in the classroom is an unnecessary government intrusion. Others were simply concerned with the legislation as written. Among those expressing legislative concerns, only one said they would support Tennessee House Bill 368 or similar legislation. Four of the 19 believed the bill was unnecessary; these educators most often believed classroom practices already had sufficient protection or the introduction of new legislation would have no impact. None of those with this viewpoint indicated they would support the discussed law. The remaining five participants had practical or what is described as logistic concerns. These individuals wanted additional information or felt teachers need more training before supporting any SSI legislation. Two of the five did select the support category despite the described reservations.

Trends in the educational lenses chosen by members of the different teaching groups can be seen in Table 130. These lenses are further divided into the subcategories which better explain the view of the participant. High school and elementary teachers who teach subjects other than science were among the groups with the lowest views of science-supported ideas in the curriculum; these were also among the groups who most often used the education lens in their arguments. Elementary science teachers had lower perception scores for SSI, but were less likely to use the educational lens.

Table 130

Total Lenses and Sub-Categories Separated by Teaching Position

		Elem, Non	Elem, Sci	Mid, Non	Mid, Sci	High, Non	High, Sci	Admin	Total
Ed Lens	Overall %	92.9	42.9	76.0	80.0	92.3	82.4	62.5	75.4
	-Critical Thinking	53.8	16.7	52.6	41.7	33.3	28.6	40.0	40.7
	-View of Sci Ed	38.5	50.0	0.0	16.7	33.3	14.3	20.0	20.9
	-Science	7.7	33.3	47.4	41.7	33.3	57.1	40.0	38.4
Sci Lens	Overall %	21.4	21.4	28.0	40.0	23.1	52.9	31.2	31.6
	-Alts	66.7	100.0	71.4	33.3	66.7	44.4	0.0	50.0
	-Science	33.3	0.0	28.6	66.7	33.3	55.6	100.0	50.0
Rel Lens	Overall %	7.1	35.7	12.0	20.0	38.5	29.4	37.5	24.6
	-Pro	100	80.0	33.3	66.7	40.0	40.0	50.0	53.6
	-Anti	0.0	20.0	66.7	33.3	60.0	60.0	50.0	46.4
Other Lens	Overall%	14.3	28.6	28.0	6.7	0.0	5.9	25.0	16.7
	-Legislative	0.0	50.0	57.1	100.0	0.0	0.0	75.0	52.6
	-Not necessary	50.0	0.0	14.3	0.0	0.0	100.0	25.0	21.1
	-Logistic	50.0	50.0	28.6	0.0	0.0	0.0	0.0	26.3

Other groups, such as high school and middle school science teachers, had high percentages for the use of the educational lens. These groups were among the most receptive of the inclusion of science-supported ideas in the curriculum. The subcategories used suggest that those who did have a positive perception score for SSI use the science subcategory more often. These arguments most often used science in direct support of science education.

The science lens was used most often by those with the highest perception of science-supported aspects of SSI in the curriculum and least often by those most supportive of the inclusion of alternative ideas. This relationship is exacerbated when subcategories are included in the analysis. Elementary teachers and secondary non-science teachers infrequently used a lens which emphasizing a view of science that supported a single, widely accepted conclusion. Secondary science teachers frequently argued that science supports only the inclusion of traditional science views.

Elementary teachers were likely to use a pro-religion lens when religion or social institutions were included in their argument. This was not true for high school science teachers, but the relationship was less clear for other teaching groups. For example, middle school science teachers were among the least supportive of the inclusion of alternative ideas in the curriculum, but were more likely to use a pro-religion/social argument when the religious/social lens was used. The low number of respondents in some categories may be somewhat responsible for the uncertain relationships. The limited number of respondents in the other lens is a possible reason for similar discrepancies. One interesting result was seen among high school science teachers.

Conclusions

Views for the inclusion of SSI were not an indicator of preferred perspective. An impressive 89% of educators were willing to include these topics in the curriculum when opposing sides were included, but slightly less than half (49.8%) showed a preference for the scientific viewpoint. A majority (61.6%) was willing to include evolution, but the preferred perspective was fairly evenly divided between those in support of science supported evolution and those who preferred the inclusion of alternative perspectives. Stem cell research showed similar results with 69.7% willing to include both sides and 49.8% preferring a perspective that addressed the rights of embryos and the benefits of research equally. Climate change had the most impressive support with 89.4% willing to include the topic, and 66.8% showing a preference for a view in support of climate change. A summary of these overall results are provided in Table 131.

Table 131

Overall Results for the Inclusion of SSI in the School Curriculum

	View measured in this study	Percentage in Support
Overall	SSI should be included in the curriculum if multiple perspectives are considered	89.0%
	Prefer the inclusion of a science supported perspective	62.6%
Evolution	Evolution should be included in the curriculum if multiple perspectives are considered	61.6%
	Prefer the inclusion of a science supported view of evolution	37.4%
	Evolution is a credible field of science	46.3%
	Evidence used to support evolution is both accurate and unbiased	33.0%
SCR	SCR should be included in the curriculum if multiple perspectives are considered	69.7%
	Prefer the inclusion of a perspective in support of research	35.3%
	Support the use of embryos in research	38.8%
	The use of embryos in medical research offers the possibility of significant medical advances	59.9%
Climate Change	Climate change should be included in the curriculum if multiple perspectives are considered	89.4%
	Prefer the inclusion of a science supported view of climate change	66.8%
	Support the science of climate change	65.0%
	Evidence used to support climate change is both accurate and unbiased	35.8%

Demographic information was not an indication of willingness to include SSI in the curriculum, but was an indication of the preferred perspective. A relationship between political ideology and the inclusion of SSI in the school curriculum was identified, with conservatives being less likely to support the inclusion of climate change in the curriculum. While all remaining groups were willing to include SSI in the curriculum, those in rural areas, Evangelicals, weekly church attendees, Republicans, and conservatives all held views that were lower than those holding other views. These differences were not significant for Evangelicals and those from rural areas when views were isolated to climate change. In multiple instances, the views held by the aforementioned groups revealed a preference for the inclusion of alternative perspectives.

Similar to demographics, number of college science courses taken was not an indication of willingness to include SSI in the curriculum. Those with the fewest hours were significantly less likely to have a preference for the inclusion of scientific ideas. When educators described their understanding of content as above average or greater, these individuals were significantly less likely to support the inclusion of pro-climate change ideas or views in support of stem cell research over the protection of embryos. Self-reported understanding of topics was not an indication of overall view of inclusion for any SSI. Evolution did show a somewhat different result. More individuals described their understanding of evolution as above average or greater and there was no difference in identified perspective. The results of the self-reported understanding of content knowledge indicate a lack of understanding for stem cell research and climate change and, perhaps, an inflated view of understanding of evolution. Table 132 illustrates differences in perspective scores with the lowest demographic group shown. The scores shown in the table are a mixture of *p*-values and *F* statistics with an $< .05$ being considered significant. Each of the demographic factors included was the lower value for t-tests and for ANOVA tests. In each ANOVA post-hoc tests found only one variable to be significantly different from the other factors.

Table 132

Differences in Science Perspective among the Demographic Group with the Lower Perspective Score

	Rural	Evangelical	Weekly Church Attendance	Republican	Conservative	Low # of Sci. Courses
All SSI	<.001	<.001	<.001	<.001 *	<.001 *	<.001
Evolution	<.001 *	<.001 *	<.001 *	<.001 *	<.001 *	<.001 *
SCR	=.003	<.001	<.001	<.001 *	<.001 *	<.001 *
Climate Change	n.s.	n.s.	<.001	<.001	<.001	=.014

* a negative perspective score was present

Highest levels of support for the inclusion of all SSI were found among secondary teachers who do not teach science, and the lowest perspectives were seen among elementary teachers. The complete results for overall and perspective scores among educators can be found in Table 133. The groups with the highest level of support for the inclusion of climate change were the inverse of those who most preferred the science-based perspective. Not surprisingly, secondary science teachers were the most supportive of the science-based perspective.

Table 133

Summary of All Results Separated by Teaching Position

		Elem, Non	Elem, Sci	Mid, Non	Mid, Sci	High, Non	High, Sci	Admin	*p*=
Overall	Inclusion	61.4	57.4	66.2	62.1	66.4	64.6	61.8	.002
	Perspective	-1.00	-3.89	4.07	8.57	.357	8.95	7.65	<.001
Evolution	Inclusion	18.3	19.4	21.8	20.7	21.6	20.4	20.4	.013
	Scientific perspective	-2.15	-5.15	.857	3.63	-.667	4.76	2.60	<.001
SCR	Inclusion	20.9	17.3	21.8	20.2	22.7	21.5	20.6	.001
	Pro-SCR research	-.032	-.857	.733	1.04	-.028	1.55	1.56	<.001
Climate Change	Inclusion	21.8	21.3	22.3	21.2	22.4	22.2	21.7	*n.s.*
	Scientific perspective	1.45	2.11	2.11	3.87	.969	2.86	2.76	.008

Less than half (46.4%) of educators were willing to say they viewed evolution as a credible field of science, and less than a third (33.0%) would describe the evidence used to support evolution as accurate and unbiased. The majority of participants (61.2%) did not support the use of embryos in research or were undecided, but most (58.7%) did believe stem cell research offered significant possibilities. Nearly two-thirds (65.1%) supported the science of climate, but only 35.8% were willing to describe the evidence as accurate and unbiased. Thankfully, support for scientific evidence was higher among secondary science teachers, but overall some improvement in support for the science behind these topics could be seen. An especially high percentage of educators seemed willing to accept the science of climate change and SCR at some point, but had not yet reached a conclusion. A complete summary of support for the science underlying each SSI is shown in Table 134.

Table 134

Support for Science Underlying Each of the SSI Included in This Study

	Overall	Elem, Non	Elem, Sci	Middle, Non	Middle, Sci	High, Non	High, Sci	Admin
Evolution science	46.4%	19.4%	10.0%	57.4%	69.6%	42.4%	68.2%	51.7%
Evidence for evolution	33.0%	11.8%	10.0%	32.7%	50.0%	26.5%	60.9%	46.4%
Use of embryos in research	38.8%	29.0%	14.3%	45.7%	41.7%	36.1%	47.8%	50.0%
SCR offers medical advances	58.7%	45.2%	26.3%	65.2%	62.5%	63.9%	87.0%	60.7%
Climate science	65.1%	38.7%	57.9%	70.8%	91.7%	50.0%	68.2%	80.0%
Evidence for climate change	35.8%	19.4%	15.8%	35.4%	50.0%	31.2%	63.6%	39.3%

The aspects of this study addressing content knowledge produced largely unsurprising results. These results can be seen in Table 135. Secondary school science teachers were in the group of those who had taken 12 or more science courses in noticeably higher percentages. The self-reported understanding of evolution was higher compared to the other SSI for all groups. Most high school and middle school science teachers described their understanding of evolution as above average. This number was highest for the two secondary science groups, but five of the seven teaching positions had scores above 50%. For stem cell research high school science teachers were the only group that felt they had an above average understanding the majority of the time (63.6%). Middle school teachers were the second highest group, but all groups outside of high school science teachers had scores below 50.0%. Climate change found similar results with higher overall percentages among both of the secondary science groups. Overall, those who had taken more science classes and those who had a higher self-reported understanding of the SSI corresponded with those groups having a more positive view of the science perspective in the classroom.

Table 135

Variations in Content Knowledge Separated by Teaching Position

	Elem, Non-Science	Elem, Science	Middle, Non-Science	Middle, Science	High, Non-Science	High, Science	Admin
12+ Sci Classes	21.6%	28.6%	14.0%	79.2%	13.9%	95.7%	43.3%
Above Average – Evolution	32.4%	60.0%	38.8%	62.5%	55.9%	72.7%	53.6%
Above Average – SCR	6.5%	28.6%	19.6%	33.3%	25.0%	63.6%	33.3%
Above Average – Climate Change	0.0%	21.1%	22.9%	58.3%	50.0%	68.2%	36.7%

An examination of demographics separated by teaching position provides some potential insights into the results of this study. These demographics separated by teaching positions are shown in Table 136. The highest percentage of Evangelicals and weekly church attendees are seen among elementary science teachers, elementary non-science teachers, and high school non-science teachers. These were also the groups with the lowest support for the inclusion of science-supported ideas in the curriculum. A similar result was seen for those identifying as Republicans and conservatives. The highest percentages for these political factors were seen among the same three groups. It is plausible that views on religion and politics might be related to the chosen career paths of the individuals. It is not, however, likely that population of the area in which the educator resides is directly related to career path. This survey found that larger percentages of elementary teachers and high school non-science teachers lived in rural areas. Thus, the implications of these findings remain somewhat murky. The relationship between demographic factors and chosen profession is an area that could possibly be studied in future research.

Table 136

Variations in Important Demographics Separated by Teaching Position

	Elem, Non	Elem, Sci	Mid, Non	Mid, Sci	High, Non	High, Sci	Admin
Evangelical	56.8%	61.9%	34.0%	33.3%	63.9%	43.5%	36.7%
Weekly Attendance	83.8%	90.5%	56.0%	62.5%	72.2%	60.9%	65.5%
Republican	52.8%	47.6%	31.2%	12.5%	51.4%	33.3%	30.0%
Conservative	75.0%	52.4%	46.9%	21.7%	61.1%	31.8%	34.5%
Rural	86.5%	81.0%	42.0%	50.0%	94.3%	43.5%	73.1%

For all three SSI teachers and scientists were selected most often as the ones who should be responsible for deciding what should and should not be included in the curriculum, while school boards and curriculum planners were listed the least frequently. Parents were seen as more important factors in decision making for SCR and evolution. This supports the view that opinions of climate change are less cemented in a moral framework. Academic sources were consistently listed most often as primary factors in reaching conclusions regarding SSI in the classroom. While listed much less often overall, religious influences had a greater impact on the groups that were less supportive of scientific perspectives.

Most educators (55.3%) were willing to accept legislation like Tennessee House Bill 368. These numbers were especially high for high school and elementary teachers who did not teach science. Opposition was above 50.0% only for high school science, administrators, and elementary science. Middle school science teachers had consistently positive perceptions of scientific perspectives, but did not oppose the legislation a majority of the time. When I tried to answer this I found 9 of 15 middle school science teachers had not provided a detailed response, making my efforts impossible. Elementary science teachers were another group which did not respond to this legislation as expected. I had expected this group to support the legislation. When I examined the responses from these educators, I found three educators in this group opposed the legislation because they opposed the inclusion of SSI altogether, which is the most likely reason for the observed discrepancy. Support for the proposed legislation was not an indicator of perspective score or overall willingness to include SSI in the curriculum. Table 137 shows support for legislation protecting the inclusion of alternative ideas among participants in this study.

Table 137

Support for SSI Legislation among Educators

	Overall	Elem, Non	Elem, Sci	Mid, Non	Mid, Sci	High, Non	High, Sci	Admin
Support legislation	55.3%	78.6%	42.9%	52.0%	60.0%	84.6%	47.1%	31.2%

Some limitations to reasoning quality were identified. Only 18.4% of respondents provided an argument from a perspective with which they did not agree, and only 10.5%

of responses received the maximum score. Reasoning quality scores were not an indicator of view of legislation, overall opinion of SSI in the curriculum, preferred perspective, content knowledge, or subject taught. Some of the respondents seemed unwilling to consider perspectives with which they did not agree, with some responses indicating a disdain for those holding opposing views. Participant 34 offered such a response: “Someone in the scientific community should not spend time responding to such a question.” This does not seem to be a positive advancement if resolutions are to be reached.

Most educators (58.4%) in this study used only one lens, while 41.3% used multiple lenses. Education was the lens most often used. This framework focused on SSI instruction, not the actual science of the topic. The use of any lens was not an indication of views of SSI legislation. Individuals were found to apply the observed lenses using different frameworks. For example, those within the education lens who emphasized the promotion of critical thinking supported the discussed SSI legislation 97.1% of the time, while those who emphasized science education as an extension of peer-reviewed science supported the legislation only 24.2% of the time. Similar differences were observed for the other identified lenses. Some used science to promote the inclusion of a scientific perspective, while other used a science lens to promote the inclusion of all ideas. Some used a religious lens to protect religious views from the intrusion of school science, while others used the same lens to protect school science from religious views.

The views of teachers have an impact on classroom instruction and science literacy. There is a general willingness to include SSI in school science, but many would only support the coverage of these topics if multiple perspectives are covered. I find some of the views held by teachers to be concerning. Low levels of support for the science behind SSI and the willingness to include alternative ideas are particularly alarming areas. As shown by previous research, such views are likely to be reflected in the learning outcomes of students. Among the educators in this study there was not a clear view in support of empirically backed science in the classroom. Views, demographic information, and teaching position were correlated with certain views of socioscientific issues. It is evident from the arguments provided by educators that those with opposing perspectives approach controversial science subjects in very different ways, and satisfactory resolutions of conflicts may be exceedingly difficult. It is my hope that socioscientific issues will be included in the classroom in a manner that is most beneficial to students and for the advancement of science literacy. Additionally, I am hopeful that the work presented here can play some role in advancing this goal.

APPENDIX A

SURVEY DOCUMENT

Permission to Participate in this Research

THE UNIVERSITY OF SOUTHERN MISSISSIPPI
AUTHORIZATION TO PARTICIPATE IN RESEARCH PROJECT

Consent is hereby given to participate in the study titled:
"View of Socioscientific Issues (SSI) among Educators: The Willingness of Educators to accept SSI into the Classroom and the Reasoning Underlying these Decisions"

1. Purpose: You are being asked to participate in a study which explores the beliefs of teachers. Specifically, this project examines the beliefs of teachers regarding potentially controversial subject matter in the science curriculum. The information you provide will be included in my dissertation and may be published in academic journals.

2. Description of Study: Those electing to complete the survey will be given a link to a third party website. This website assists in the collection of anonymous data. The survey you will be asked to complete includes multiple-choice and open-ended prompts. It is estimated that completing the first part of the survey should take approximately 15 minutes. The second part of the survey should take an additional 20 minutes. Answers will be analyzed for those individuals who complete one or both portions of the survey.

3. Benefits: In addition to the potential value of a publication, those respondents electing to complete this survey will be offered the opportunity to register to win a notebook computer. The information collected for this prize will be collected via a separate email account and will not be associated with your answers to the survey.

4. Risks: This study includes no known risks. Those comfortable with ordinary use of a computer should have no reason to anticipate any discomfort. Even though injury is highly unlikely, those feeling they have been injured or those concerned with the possibility of injury may contact John Parr at (731) 592-4515 or john.parr@eagles.usm.edu. You should also understand that The University of Southern Mississippi has no mechanism to provide compensation for participants who may incur injuries as a result of participating in research projects. However, efforts will be made to make available the facilities and professional skills at the University.

5. Confidentiality: The information you provide will be collected in an anonymous manner. No one will be able to match responses with identifying information. The information you provide may be published, but your personal information will remain strictly confidential.

6. Alternative Procedures: Participation in this study is completely voluntary. If you would like to complete the survey using a printed copy of the instrument please contact John Parr at (731) 592-4515 or john.parr@eagles.usm.edu.

7. Participant's Assurance: Whereas no assurance can be made concerning results that may be obtained (since results from investigational studies cannot be predicted) the researcher will take every precaution consistent with the best scientific practice. Participation in this project is completely voluntary, and participants may withdraw from this study at any time without penalty, prejudice, or loss of benefits. Questions concerning the research should be directed to John Parr at (731) 592-4515. This project and this consent form have been reviewed by the Institutional Review Board, which ensures that research projects involving human subjects follow federal regulations. Any questions or concerns about rights as a research participant should be directed to the Chair of the Institutional Review Board, The University of Southern Mississippi, 118 College Drive #5147, Hattiesburg, MS 39406-0001, (601) 266-6820.

***1. Do you give your consent to participate in the following study?**

- ○ Yes, I consent to participate in the study described above.
- ○ No, I do not consent to participate in the study described above.

Background Information

1. What is your gender?

- ○ Male
- ○ Female

2. Which of the following best describes your ethnicity?

- ☐ Caucasian
- ☐ African American
- ☐ Hispanic/Latino
- ☐ Asian

Other (please specify)

3. Which of the following describes your highest level of formal education completed?

- ☐ Current undergraduate student
- ☐ Completed Bachelor's degree
- ☐ Current graduate student
- ☐ Completed graduate degree

Other (please specify)

4. How many science classes in the following categories did you take while in college?

	0	1 - 2	3 - 5	6 - 9	10+
Biology or Life Sciences	☐	☐	☐	☐	☐
Chemistry	☐	☐	☐	☐	☐
Physics or Astronomy	☐	☐	☐	☐	☐
Earth Sciences	☐	☐	☐	☐	☐

5. What grade(s) and subject(s) do you currently teach?

- ☐ Lower Elementary (K-2)
- ☐ Upper Elementary (3-5)
- ☐ Middle School (6-8)
- ☐ High School (9-12)

Other (please specify)

6. In what type of school do you teach?

- Public
- Private - Secular
- Private - Religious

Other (please specify)

7. In what state do you teach?

State:

8. Which of the following describes the city/town where you teach?

- Rural (less than 2,500 people)
- Somewhat Rural (2,500 to 25,999)
- Somewhat Urban (26,000 to 49,999)
- Urban (50,000 or more people)

9. Are you required to teach science?

- Yes
- No

10. What science classes are you certified to teach?

- Biology (7-12)
- Chemistry (7-12)
- Physics (7-12)
- Earth Science (7-12)
- Middle School Science (6-8)
- None

Other (please specify)

11. Which of the following best describes your religious affiliation?

- Protestant
- Catholic
- Mormon
- Jehovah's Witness
- Jewish
- Muslim
- Hindu
- Buddhist
- Atheist
- Agnostic

Other (please specify)

Background Information

1. If Protestant, how would you describe your specific Protestant denomination?

- ☐ Baptist - Evangelical (Southern Baptist, etc.)
- ☐ Baptist - Mainline (American Baptist, etc.)
- ☐ Baptist - Historically Black (National Baptist, etc.)
- ☐ Methodist - United Methodist
- ☐ Methodist - African Methodist Episcopal
- ☐ Lutheran - Evangelical Lutheran
- ☐ Lutheran - Missouri Synod
- ☐ Pentecostal - Assembly of God
- ☐ Pentecostal - Church of God in Christ
- ☐ Presbyterian Church USA
- ☐ Presbyterian Church America
- ☐ Church of Christ
- ☐ Disciples of Christ
- ☐ Episcopal/Anglican
- ☐ Church of the Nazarene
- ☐ Free Methodist Church
- ☐ Seventh Day Adventist

Other (please specify)

2. How often do you attend religious services?

- ○ More than once a week
- ○ Once a week
- ○ Once or twice a month
- ○ A few times a year
- ○ Rarely
- ○ Never

Other (please specify)

3. How would you describe your political party affiliation?

- ○ Democrat
- ○ Republican
- ○ Independent

Other (please specify)

4. How would you describe your political ideology?

- Conservative
- Progressive/Liberal
- Moderate
- Libertarian

Other (please specify)

5. Which of the following sources of information has had the greatest impact on your understanding of science?

You may pick more than one answer.

- Academic sources (teachers, professors, academic texts, etc.)
- Religious sources (members of the clergy, religious texts, etc.)
- Television Programs
- Non-academic Websites
- Other media (newspapers, magazines, etc.)
- Family Members
- Friends

Other (please specify)

Embryonic Stem Cell Research

The following questions address your beliefs concerning the teaching of ideas related to embryonic stem cell research (ESCR). The questions refer only to discussions of embryonic stem cell research. They do not refer to conducting labs using embryos.

Definition of embryo: In the broadest sense, human embryos can be described as a human entity in the earliest stages of development. This development begins following the fertilization of an egg by a sperm and ends after about eight weeks of development. After this stage the embryo is called a fetus until birth.

1. Science classes should include ethical discussions on stem cell research.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Level of Agreement	○	○	○	○	○

2. Science classes should include discussions on the rights of human embryos.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Level of Agreement	○	○	○	○	○

3. Science classes should include descriptions of the medical benefits that could result from embryonic stem cell research.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Level of Agreement	○	○	○	○	○

4. Science classes should assist students in weighing the rights of embryos versus the rights of individuals who might be helped by stem cell research.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Level of Agreement	○	○	○	○	○

5. Proponents of embryonic stem cell research believe that it is possible to conduct embryonic stem cell research in an ethically appropriate manner.

Science classes should include arguments to support the view that embryonic stem cell research can be conducted in an ethically appropriate manner.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Level of Agreement.	○	○	○	○	○

6. Some opponents of embryonic stem cell research believe that the human embryo is a full human being worthy of all rights given to other humans, regardless of any circumstance. This view prevents any consideration for the possibility of embryonic stem cell research.

Science classes should include the previously described view.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Level of Agreement	○	○	○	○	○

7. Indicate your level of support for allowing the use of human embryos in medical research.

	Strongly Oppose	Oppose	Neutral	Support	Strongly Support
Level of Support	○	○	○	○	○

8. How strongly do you agree/disagree with the following statement:

Using human embryos in medical research offers the possibility of significant medical advances.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Level of Agreement	○	○	○	○	○

9. How would you describe your own understanding of embryonic stem cell research?

	Extremely Poor	Below Average	Average	Above Average	Excellent
Level of Understanding	○	○	○	○	○

10. Teaching the ethics of stem cell research can reveal differences between members of the scientific community and those involved with local schools. Whose opinion should be most important in framing the ethics of stem cell research within the science classroom?

You may pick more than one answer.

- ☐ Members of the scientific community
- ☐ Teachers
- ☐ School administration (school and/or district personnel)
- ☐ School board members
- ☐ Parents
- ☐ State-level curriculum planners
- ☐ National curriculum planners

Other (please specify)

____

Evolution

In the following questions and answer choices the word "evolution" refers to a long history of life on Earth and the interrelatedness of living things.

1. Evolution should be a part of some science classes.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Level of Agreement	○	○	○	○	○

2. Alternatives to evolution, such as creationism and intelligent design, should be a part of some science classes.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Level of Agreement	○	○	○	○	○

3. Science classes should include information that supports evolution.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Level of Agreement	○	○	○	○	○

4. Science classes should include information that supports one or more alternatives to evolution, such as creationism and intelligent design.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Level of Agreement	○	○	○	○	○

5. Science classes should include information that supports the evolution of humans.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Level of Agreement	○	○	○	○	○

6. Science classes should include information that supports the role of a divine creator in the development of humans.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Level of Agreement	○	○	○	○	○

7. Indicate your level of support for evolution as a credible field of science.

	Strongly Oppose	Oppose	Neutral	Support	Strongly Support
Level of Support	○	○	○	○	○

8. How strongly do you agree/disagree with the following statement:

The evidence used to support evolution is both accurate and unbiased.

	Strongly Disgree	Disagree	Neutral	Agree	Strongly Agree
Level of Agreement	○	○	○	○	○

9. How would you describe your own understanding of the theory of evolution?

	Extremely Poor	Below Average	Average	Above Average	Excellent
Level of Understanding	○	○	○	○	○

10. Views regarding the teaching of evolution can reveal differences between members of the scientific community and those involved with the local schools. Whose opinion should be most important in framing the treatment of evolution in a science classroom?

You may pick more than one answer.

- ☐ Members of the scientific community
- ☐ Teachers
- ☐ School administration (school and/or district personnel)
- ☐ School board members
- ☐ Parents
- ☐ State-level curriculum planners
- ☐ National curriculum planners

Other (please specify)

Climate Change

In the following questions the term "climate change" refers to a negative change in the environment that is greater than normal variations in weather.

1. Science classes should include information which supports the idea that climate change is occurring.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Level of Agreement	○	○	○	○	○

2. Science classes should include information which supports the idea that climate change is simply a result of natural processes.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Level of Agreement	○	○	○	○	○

3. Science classes should include information which supports the idea that pollution from humans is having a negative impact on the climate.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Level Agreement	○	○	○	○	○

4. Science classes should include information which supports the idea that actions to combat climate change will have a negative impact on the U.S. economy.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Level of Agreement	○	○	○	○	○

5. Science classes should include information that supports the idea that actions exist which would reverse or limit climate change.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Level of Agreement	○	○	○	○	○

6. Science classes should include information which supports the idea that no effective actions exist to limit or reverse the effects of climate change.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Level of Agreement	○	○	○	○	○

7. Indicate your personal level of support for the science of climate change.

	Strongly Oppose	Oppose	Neutral	Support	Strongly Support
Level of Support	○	○	○	○	○

8. How strongly do you agree/disagree with the following statement:

The evidence used to support the existence of climate change is both accurate and unbiased.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Level of Agreement	○	○	○	○	○

9. How would you describe your own understanding of climate change?

	Extremely Poor	Below Average	Average	Above Average	Excellent
Level of Understanding	○	○	○	○	○

10. Teaching certain aspects of climate change can reveal differences between members of the scientific community and those involved with local schools. Whose opinion should be most important in framing the teaching of climate change within the science classroom?

You may pick more than one answer.

- ☐ Members of the scientific community
- ☐ Teachers
- ☐ School administration (school and/or district personnel)
- ☐ School board members
- ☐ Parents
- ☐ State-level curriculum planners
- ☐ National curriculum planners

Other (please specify)

APPENDIX B

OPEN-ENDED QUESTIONNAIRE

Controversy in the Classroom

PLEASE READ THE FOLLOWING ARTICLE AND ANSWER THE QUESTIONS BELOW.

Tennessee House Bill 368 is the latest in a long and colorful history of laws governing science in the classroom. Opponents have described the legislation as an attempt to insert non-scientific ideas into the science classroom. Supporters insist the measure is an attempt to protect and promote fairness within Tennessee's public schools. The bill states, "Some teachers may be unsure of the expectations concerning how they should present information on (controversial science) subjects." These controversial subjects include, but are not limited to, "biological evolution, the chemical origins of life, global warming, and human cloning." The bill encourages those "unsure" teachers to emphasize a balanced treatment of controversial subject matter. This language all seems to render little emotion or reason for debate, but critics of the measure believe the bill is simply a disguised attempt to weaken firmly established scientific ideas.

TN House Bill 368 encourages teachers to emphasize the "scientific strengths and weaknesses" surrounding the previously mentioned subjects. One of the bill's sponsors, Bill Dunn, has said the bill is about "helping students develop critical thinking skills and using objective scientific facts." Mr. Dunn emphasizes the bill is not about religion, but is instead an attempt to prevent a "one-sided debate" that is not based on "objective scientific facts". The proposed legislation was initially the idea of David Fowler of the Family Action Council of Tennessee. Mr. Fowler was motivated to take action after hearing complaints that one teacher's presentation of evolution was, what he referred to as, "extremely unbalanced". The proposed legislation relies on the assumption that a reasonable controversy exists, and that those opposed to the generally accepted views of science deserve to be given time to express their beliefs. This is not an assumption that is supported by everyone.

Several science groups believe that those who support the proposed law are not basing their beliefs on sound scientific principles. These groups have described the legislation as unneccesary and that no significant "weaknesses" exist with the science topics in question. The American Association for the Advancement of Science (AAAS) is one of the groups opposed to TN House Bill 368. The AAAS believes, "There is virtually no scientific controversy among the overwhelming majority of researchers on the core facts"; and the proposed legislation "will only confuse students, not enlighten them." Roger Cone and Jon Kaas from Vanderbilt University along with Robert Webster from St. Jude's Children's Research Hospital have openly sided with the bill's detractors. Cone, Kaas, and Webster worry about the unforeseen impact of House Bill 368 and believe the bill could allow teachers to openly "miseducate" students. Opponents of the proposed legislation would argue that a balanced presentation is not necessary because one side of the debate is based on a belief system that is not supported by "objective scientific facts".

It seems that both sides would agree that the proposed law encourages teachers to explore the "scientific weaknesses of existing scientific theories." The law specifically mentions evolution and global warming; while not directly mentioned, the ethics of stem cell research is certainly another area that could be impacted by the proposed legislation. Under TN House Bill 368 teachers might be encouraged to emphasize weaknesses or uncertainties surrounding evolution, stem cell research, and global climate change. Supporters of the bill say they are promoting a balanced examination of unsettled scientific matters. Opponents of the law believe that a balanced view is impossible because these scientif

1. Would you support legislation, like TN House Bill 368, which is designed to promote the "balanced" coverage of controversial science topics? Please explain your answer.

2. If you wanted to convince others to support your view of TN House Bill 368 or similar legislation, what argument would you use to support your position?

3. Given the nature of this legislation many people will certainly hold a position which opposes the view you described in question 2.

For this question consider a viewpoint which directly conflicts with your own opinion. What is the best argument that might be offered by someone trying to persuade you to support this opposing position?

4. To justify your own position, what argument would you provide to counter the claims you provided in question 3? What problems exist with the argument you described in question 3?

APPENDIX C

INSTITUTIONAL REVIEW BOARD NOTICE OF COMMITTEE ACTION

THE UNIVERSITY OF
SOUTHERN MISSISSIPPI

INSTITUTIONAL REVIEW BOARD
118 College Drive #5147 | Hattiesburg, MS 39406-0001
Phone: 601.266.6820 | Fax: 601.266.4377 | www.usm.edu/irb

NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months. Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: **12021602**
PROJECT TITLE: **View of Socioscientific Issues (SSI) Among Educators: The Willingness of Educators to Accept SSI into the Classroom and the Reasoning Underlying these Decisions**
PROJECT TYPE: **Dissertation**
RESEARCHER/S: **John Parr**
COLLEGE/DIVISION: **College of Science & Technology**
DEPARTMENT: **Center for Science & Math Education**
FUNDING AGENCY: **N/A**
IRB COMMITTEE ACTION: **Expedited Review Approval**
PERIOD OF PROJECT APPROVAL: **04/03/2012 to 04/02/2013**

Lawrence A. Hosman, Ph.D.
Institutional Review Board Chair

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